Engineering
Library

FEB 21 1921

More than 25,000 Copies per Week

Electrical World

McGraw-Hill Company, Inc. New York, February 19, 1921 Twenty-five Cents a Copy

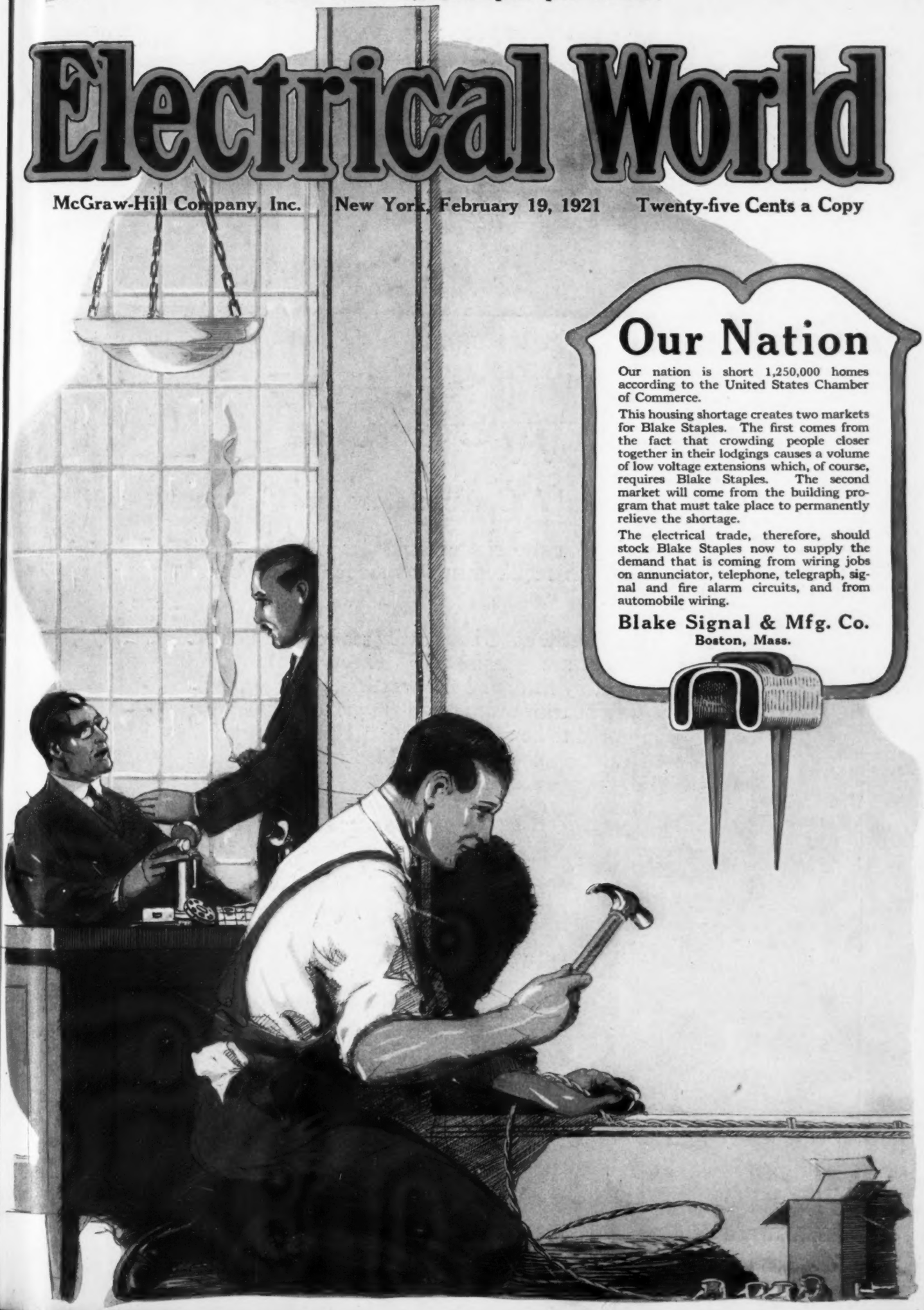
Our Nation

Our nation is short 1,250,000 homes according to the United States Chamber of Commerce.

This housing shortage creates two markets for Blake Staples. The first comes from the fact that crowding people closer together in their lodgings causes a volume of low voltage extensions which, of course, requires Blake Staples. The second market will come from the building program that must take place to permanently relieve the shortage.

The electrical trade, therefore, should stock Blake Staples now to supply the demand that is coming from wiring jobs on annunciator, telephone, telegraph, signal and fire alarm circuits, and from automobile wiring.

Blake Signal & Mfg. Co.
Boston, Mass.



On the Switchboards of the World-

Weston

Switchboard A.C. Ammeters and Voltmeters

operating on the electromagnetic principle, fully meet all the requirements of modern switchboard practice.

These Instruments have easily read scales. Pointer vibrations are eliminated. They are protected against stray fields and are practically unaffected by changes in temperature and frequency. They are guaranteed to be accurate within 1 per cent of full scale value on any commercial frequency as high as 133 cycles per second.

Model 156

Bulletins 1502 and 1503 give complete information. Write for them.

Weston Electrical Instrument Co.
13 Weston Ave., Newark, N. J.

New York	Buffalo
Chicago	Minneapolis
Philadelphia	New Orleans
Boston	Jacksonville
Cleveland	Seattle
Detroit	Toronto
St. Louis	Montreal
San Francisco	Halifax
Denver	Winnipeg
Cincinnati	Vancouver
Pittsburgh	Calgary, Alta.
Richmond	

And in Principal Cities Throughout the World

Electrical World

The consolidation of Electrical World, Electrical Engineer and American Electrician
Published by McGraw-Hill Company, Inc.

W. H. ONKEN, Jr., Editor D. H. BRAYMER, Managing Editor
S. B. WILLIAMS, Assistant Managing Editor A. M. PERRY, Engineering Editor J. C. MARTIN, Western Editor G. E. ARMSTRONG, Pacific Coast Editor H. S. KNOWLTON, New England Editor
Associate Editors: P. S. BIEGLER, C. T. BALDWIN, S. N. CLARKSON,
R. H. BACON, T. P. KINDIG, R. M. DAVIS, E. H. HUBERT, F. C. WELLS

Volume 77 New York, Saturday, February 19, 1921 *Number 8*

Chicago Chosen for N. E. L. A. Convention

BY A HAPPY decision the next convention of the National Electric Light Association will be held in Chicago. This augurs well for a large attendance and a successful meeting, for Chicago knows how to do things and its slogan "I will" typifies its spirit. To electric light and power men Chicago is particularly interesting because it is the abode of the industry's chief counsel and guide, Samuel Insull, and because it possesses some of the largest and most efficient steam-electric generating stations in the world. Were that all, it would be enough, but space does not permit the enumeration of the city's other assets. Volumes have been written on them, and material for fresh volumes is forthcoming daily. A visit to Chicago at any time will amply repay one, and the electric light convention is an added recompense. Managers, engineers and commercial agents should make it a point, therefore, not to overlook the week beginning May 29.

Customer Ownership and Public Opinion

CUSTOMER ownership of public utility securities develops a new sense of responsibility among the users of service, and if it is long continued it will greatly benefit operating managements by reflex action. The closer the relationship between public and company the better. Acquisition of property has a sobering influence upon radicalism, and in a community where the savings of citizens are invested in the local utility the chances of fair treatment are multiplied and the likelihood of serious disputes is reduced. It will be interesting to watch the course of proposed radical legislation in communities where the customer-ownership idea gains headway. Participation in the business of a local utility through investment in its shares bodes ill to the demagogue whose success in the past has so often been based upon appeals to ignorance and indifference in districts holding false notions or no ideas at all about local utilities. In addition alert managers will do well not to overlook the opportunities for taking their local investors into their confidence about company affairs. The educational possibilities are little less than wonderful. Worth-while "tips" to those in operating charge may often come from very humble sources. But most important of all is the opportunity for that contact between company and customer which contains so much potential good. The mighty force of public opinion is being harnessed for the mutual benefit of utilities and their patrons where customer ownership is treated as something beyond the mere speculative buying and selling of an interest in the property. If this great movement continues to develop, it will not be long before it will be credited with a vast amount of constructive influence on popular thinking about utility corporations, and new faces will appear at commission hearings in popular support of company policies.

Search for Economy Should Not Be Curtailed

THE conclusion reached from studying the tendencies of the day that a general effort toward economy exists. Operating companies are trying to reduce their overhead and underground costs, both as to construction and as to operation, without impairing service. It is more than an attitude forced by lack of money; it is a healthy consequence of the general extravagance of the last few years. That which has been accomplished so far only shows what a very small part of the actual possibilities have been investigated. The danger therefore is that, blinded by this desire for economy, investigations, searches, analyses, all of which represent expenditures, will be stopped for the sake of saving a few dollars and the infinitely larger savings that such work makes possible be lost. Further, this work must be done with thorough engineering application and judgment, which also represent expenditures, in order that it shall not be necessary to retrace steps. Those who will consider with unbiased mind what engineering effort has accomplished so far cannot but encourage investments of relatively small funds that hold unlimited promises of economy for the future.

What Are Utility Property "Values"?

DO UTILITY property values depend on current market prices of the component parts, or is there some other basis that will represent values in a more nearly correct light? Arguments for present-day or market values as a basis for rate making have met with favor in court decisions. These arguments are apparently founded on the theory on which merchandise stocks, which depend for their revenue-producing ability on the sale of the individual items to the customer, are valued. Whether the cases are parallel is an undecided question. Manufacturing plants are put together with labor and material purchased in open market to produce a salable product. The value of the plant as a manufacturing establishment depends to some extent on the market value of its parts, but its ultimate value is chiefly determined by the skill with which the parts are assembled and operated to turn out the factory product. If the product can be turned out at a low cost and the organization as a whole is efficient, the value of the assembled plant is enhanced by the profit on the sale of goods. If the assembly is unskillful, the management incompetent and the owner must face a competitive

market, he is at a disadvantage that will ultimately make it impossible to dispose of the product, and his plant speedily sinks in value to the price of the salvage that can be had. In a business field where free competition exists economic forces provide the penalty for incompetence or errors in judgment, and equally they reward efficiency.

The elimination of competition in utility operation by the establishment of commission regulation does not relieve the industry from the effects of incompetence or bad judgment or the necessity of reward for efficiency, nor does it change the fundamental basis of plant values. Commission regulation is designed to do constructively certain things that, because of conditions, competitive effort either will not do or will accomplish through a destructive process. The ultimate result, however, must be that which is obtained in the business field. If this reasoning be sound, a utility property may be considered as a manufacturing plant into the value of which the market prices of labor and material to construct enter as a factor. The price of its product will vary with conditions that bear little relation to the pure physical plant except as to its efficiency of production. The primary factor in property values that does bear a vital relation to the price of its product is the skill with which the physical and commercial components have been assembled and managed to give service. It therefore follows that in one form or another skill must be rewarded in proportion to its efficiency or the organization penalized for its incompetence. Whether the present trend of court decisions on the question of values will clear or becloud the issues is a matter of moment to public utilities. Serious study of the problem of what really constitutes value in a utility property is needed.

Procedure that Simplifies the Lighting Problem

EFFECTIVE lighting can be evaluated best by the results determined after it has been installed. No matter how carefully the design may be conceived and executed, unless all the factors are considered and taken care of the results may not be satisfactory to the user. These sometimes intangible, or at least unforeseen, details have caused many of the unsatisfactory layouts for lighting in industrial plants. That this has been true is not a reflection on the designer, but rather goes to show that lighting perfection can come only through experience. As the development of the art proceeds, no doubt new factors will still arise which will have to be considered in order to gain the fullest efficiency in the use of artificial illumination.

In this issue E. A. Anderson shows how it is possible to take up the subject of lighting design in four logical steps and almost automatically to allow for the many variable factors. A new term, called the "room index," enters into this method. This room index takes into consideration the length and width of the room, as well as the mounting height of the lighting unit above the working plane, so as to make it possible to turn to the various types of lighting units and by a consideration of the reflection factor of the walls determine accurately the coefficient of utilization. This work is not the result of theory or empirical formulas, but comes through long observation and study by the staff of the National Lamp Works.

While this method does not entirely eliminate the possibility of further and careful consideration, particularly in cases of special lighting, where the psychological and physiological effects must be considered, it is sufficiently comprehensive for most practical work. The greatest merit of the plan is that it is easily understood and when put into effect will certainly give results far more accurate than the methods by which most lighting installations have been designed in the past.

To See Ourselves as Others See Us

A RECENT number of the *Electrician* of London contained an interesting report on American electrical practice by S. L. Pearce of the Manchester Electricity Department, who was sent to this country to make a careful study of operating conditions in the larger plants with a view of getting a conspective notion of recent American practice. Those who know Mr. Pearce realize that a very keen intelligence and sharp pair of eyes have been fixed on the way we do things and that his recorded conclusions are correspondingly valuable. Perhaps the most surprising of his notes is that which suggests that steam-turbine practice in this country is less advanced than in England and that, comparing the best plants in each country, ours show the lower operating efficiencies. We should like fuller details on this matter before passing judgment, but our offhand inclination would be to ascribe the difference to the rapid changes that have taken place in American operating conditions during the war, and particularly to the rapid increase in costs of machinery, which have not always tended toward producing equipment of the highest possible efficiency irrespective of first cost. If this view of the situation be correct, it should rapidly be remedied under stress of the high costs of fuel still maintained and the removal of the abnormal requirements brought about by war loads. The same general conditions probably account, as Mr. Pearce evidently realizes, for the difference in boiler practice which forces American units to a considerably higher rating than is usual in British practice, by reason of the effect of high investment costs.

A number of other differences in practice noted are more or less the result of chance, like the considerable variation in engineering voltages of somewhat higher periodicity and the general use of overhead rather than underground lines in American practice. It is self-evident that with the widespread distribution from urban plants common in this country, as compared with the more compact areas served by most British plants, the use of overhead service whenever possible is an economic necessity and there is no considerable probability of our changing to underground distribution on any such scale as is attempted abroad. A curious variation in practice, however, is found and emphasized by Mr. Pearce with respect to the service pressures of supply, where American practice runs to just about one-half of the figures found in the typical English, or for that matter over-seas, plant. This is virtually the only country of importance which does not freely use incandescent lamps and other apparatus of intimate distribution at from 220 volts to 250 volts. What this means in distribution losses or distribution cost, according to whether we take one horn of the dilemma or the other, is too evident to require comment. The causes of this particular difference, which runs exactly counter

to the general bold trend of American engineering, are somewhat complicated. The long-established custom of lamp renewals free or at moderate cost—a custom only gradually being discontinued—has been one powerful influence at work, and the close relations between central stations and lamp manufacturers have been another. In addition, the very large number of motors and appliances already standardized and in use affords strong reason for hesitating at so radical a change as that from a 110-volt to a 220-volt service. It is probably safe to say, however, that if one could start *de novo* with a big urban plant, a secondary system at 110 volts would receive no more consideration than a primary system at 1,000 volts.

Despite the criticisms referred to and some other minor ones which Mr. Pearce makes, he has freely to admit that in the big American plants the cost of electrical energy is not only relatively but often actually cheaper than in England. We may slip up in details of practice occasionally, but in the large items of efficient operation a very high rank must be accorded to our central stations. Particularly is this true of interconnection, co-ordinated working covering in some cases, as Mr. Pearce notes, areas nearly as large as the whole of England. His estimate of American practice leaves us, on the whole, much to be proud of, albeit it brings sharply to our notice some details which from their very familiarity to us can best be seen by a sharp-eyed outsider.

Electrical Inspectors Seek Co-operation

APPOINTMENT by the Western Association of Electrical Inspectors of an industrial and an associate member to its executive committee is a commendable move in the direction of co-operation in the inspection field. This is done under the revised articles of association adopted at the recent Detroit meeting. When it is realized that these two committee members are from a group that has no vote in the open sessions of the association the significance of the action becomes more apparent. The feeling between the men called upon to handle the work of inspecting electric installations and those intrusted with the duty of installing and operating them has not always been of the pleasantest character, largely because there has been more or less lack of understanding of the functions of the various inspection organizations in their relations with the other branches of the industry. Fortunately that lack of understanding has been rapidly disappearing in the last few years and is being replaced by a feeling that all are a part of the same industry and that any apparent conflict of interest is due to a lack of co-ordination of the different fields of activity. The result is a better understanding in the electrical field of the functions of the inspector, and the inspector, on the other hand, is appreciating more and more the difficulties under which the work he must deal with is done.

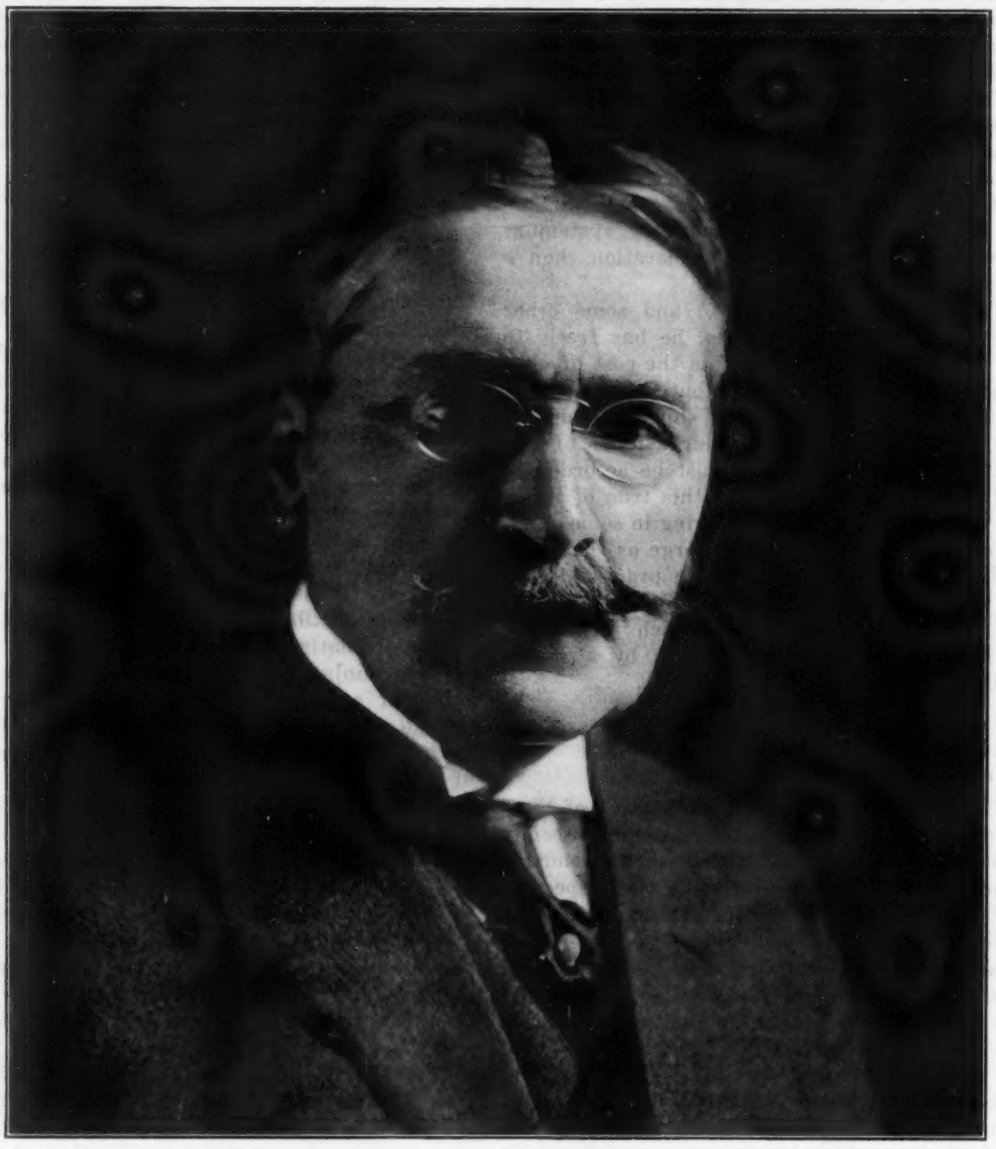
It is regrettable that the spirit of the discussion at Detroit when the article providing for the representation came up for consideration cannot be imparted to every public utility and industrial man whose work is affected by inspection bureaus. The purpose of the move is to give the other branches of the industry vitally interested an opportunity to make their needs known, and to provide another method whereby hasty and ill-considered action can be halted and a thorough discussion on the part of all interested brought about before the action has gone so far that it is difficult to recall and that severe criticism has arisen. The association is endeavoring to provide every safeguard against unwise action. Its move should be met in the spirit in which it has been taken, and all branches of the industry should lend help to give it success.

Increasing Maximum Working Voltages in Cables

THE maximum stress on the insulation of high-voltage cables as at present manufactured is well below the dielectric strength of the principal ingredients used. All high-class fluid insulating compounds in the pure state have dielectric strength higher than that of a gas, and yet the maximum permissible stresses in cables are lower than the dielectric strength of air. This anomalous situation is caused by the difficulty of securing a homogeneous structure and the elimination of voids, or gas bubbles, in all types of built-up insulation. These gas pockets develop ionization at relatively low voltages, resulting ultimately in destruction of the insulation. The condition is well known in armature coils, and in cables is further complicated by the requirement of mechanical flexibility. At present the dielectric strength of the insulating material has relatively little weight in determining the total thickness of insulation in a cable for a given service. This is further emphasized by the fact that no consideration has yet been given to the increased stress on the insulation due to stranding of the conductor. It is well known that stranding a conductor in air materially increases the stress at the surface.

Recent research in this field and further knowledge of the facts are causing cable designers to look forward to the time when the dielectric strength of pure material may be more nearly approached as the limit of permissible stress, and so to increase permissible cable voltages. In the January number of the A. I. E. E. *Journal*, Messrs. Davis and Simons present a valuable survey of the present situation in the matter of cable design. Tables are given for determining the maximum insulation stress arising in single and three-conductor cables in terms of their dimensions. An analysis is also given leading to the determination of the minimum value of maximum stress for a triplex cable of given outside diameter and to the conclusion that this minimum value of stress will be attained when the conductor diameter equals the core diameter divided by 5.94.

Cable designers are apparently not in complete accord as to the present maximum permissible stress, the authors referred to proposing 25 kv. per centimeter, while other well-known engineers propose 19.5 kv. per centimeter. Using these two figures and the analysis developed, the authors of the paper have computed the maximum safe working voltages which may be used on several types of cables of core diameters from 2½ in. to 3½ in. (6.3 cm. to 8.9 cm.), as limited by the size of underground duct. The results of this analysis indicate a maximum voltage of about 34 kv. for a cable with core diameter of 3½ in. and maximum insulation strength of 25 kv. per centimeter. It is also proposed that the Hochstader triplex cable, in which the insulation of each conductor is wrapped with copper foil, may eventually operate at a stress of 40 kv. per centimeter. On this basis 50,000 volts is proposed for this type of cable.



Michael Idvorsky Pupin

Who this week received the Edison medal, the greatest honor the electrical industry has to offer, for his work in mathematical physics and its application to the electrical transmission of intelligence

IT IS seldom that one man does so many great things for one branch of science as Prof. M. I. Pupin has accomplished for the art of communication. In both wired and wireless work his discoveries have been of fundamental importance. But for his discovery of the loading coil the use of the telephone would still be restricted to comparatively short distances. Through the economy in wire effected thereby many millions of dollars have been saved. His early work in electrical resonance resulted in the use of tuned circuits for selective receiving of signals. This principle of tuning has had a profound effect on the wider use of the wireless. A further refinement in the wireless art contributed by Professor Pupin is the polarized electrolytic-cell method of rectifying both low-frequency and high-frequency oscillations to make them detectable by direct-current instruments. He has of late years been engaged in perfecting a method for eliminating the effects of static on radio waves, and one of his more recent contributions has been the so-called negative resistance compensator. In 1917 he presented to the United States government the use of his invention decreasing static interference.

Professor Pupin, who this week received the Edison medal, which was awarded to him by the American Institute of Electrical Engineers "for work in mathematical physics and its application to the electrical transmission of intelligence," was born of Serbian parents in Idvor, Banat, Hungary, Oct. 14, 1858. He came to the United States in 1874 and after five years of hard manual work had saved enough money to enter Columbia College, from which he was graduated in 1883 with high honors. He took post-graduate work in physics and mathematics at the University of Cambridge, England, and the University of Berlin, Germany. In 1889 he returned to Columbia University and with Prof. F. B. Crocker started the electrical engineering department at Columbia as instructor in mathematical physics. Professor Pupin has remained at Columbia ever since and now occupies the chair of electromechanics, besides being director of the Phœnix Research Laboratory of the university. For his researches he has received many honors, including the Herbert prize in physics from the French Academy and the Carson gold medal from the Franklin Institute. He is a member of numerous technical societies, in some of which he has taken a prominent administrative part.

During the war he served on several war-work committees, including a government committee for submarine detection with headquarters at New London, Conn., where he and his staff developed a method for detecting submarines at rest and determining their exact position. The further development of this work is now in the hands of the United States Navy.

Higher Temperatures in Cable Insulation

Low-Tension Cables Were Subjected to Intermittent Tests at Excessive Loads with Little Damage to Insulation—Higher Temperature Limits Are Recommended Based Upon Load Factor

A STRONG plea for higher temperature limits in low-tension paper-insulated cables was made by Philip Torchio, chief electrical engineer of the New York Edison Company, in a paper, entitled "Permissible Operating Temperatures of Impregnated Paper Insulation in Which Dielectric Stress Is Low," read this week at the mid-winter convention of the American Institute of Electrical Engineers. He emphasized the point that while in machinery the 105-deg. allowable limit is reached for long periods of time in the operation of the apparatus, on the other hand, low-tension cables, as commonly used in large distributing systems, are not subjected to the maximum temperature except for short periods of time each day, so that in such cases the 105 deg. C. for the low-tension cable is, in his opinion, immeasurably safer than 105 deg. for machinery. The author believed that the limiting temperature should be a function of the load factor (average load to yearly maximum) under which the apparatus is to operate, so that if the apparatus, either cable or machinery, is to operate for long hours at full load, the limiting temperature should not exceed say 90 deg. C., while, on the other hand, if the cable or machinery is to operate for a short time at heavy load and then be subjected to a long period of cooling, the limiting temperature for the peak loads should be raised and the 105-deg. limit should be standardized.

After a considerable review of the work of the British Engineering Standard Committee in 1905 and later work by Steinmetz and Lamme,* Mr. Torchio took up reasons advanced for low temperature limits used for low-tension cables. The principal reasons given for having adopted a temperature lower than 105 deg. C. for class A insulation in electrical machinery are: (1) that the compound, when warm, may leave the paper on the top of the cable and collect in the bottom, (2) that cables are often removed for reinstallation, and if the paper has become brittle, it will crack inside the lead sheath. Another reason advocated is that the expansion and contraction of long lengths of large size lead-covered cables may cause cracking of the lead sheath at sharp bends in manholes.

When Higher Temperature Is Considered Safe

The author then submitted evidence which he considers conclusive that 100 deg. C. to 110 deg. C. is safe and standard practice in large subway and distributing systems. This evidence consists of (1) results from observations obtained by wide and close scrutiny of the physical and electrical conditions of all the low-tension cables of a large electric power company, the New York Edison Company, and (2) results of special tests carried out by engineers and laboratory men.

In this system heavier loads were carried by the cable than previously in the period of the winter of 1919, when some serious short circuits occurred among the low-tension cable feeders.

Results of physical inspection show that a number of 1,000,000-circ.mil concentric cables, in congested banks of ducts, had their sheaths cracked near the edge of the ducts and at sharp bends in manholes. The movement of the cables due to expansion and contraction was impeded. These cracks extended to the insulation, leaving an open path for moisture and water to reach the copper and causing local short circuit. But it was noted with interest that the cable insulation was unimpaired a few feet from the crack or burn-out. Extensive tests were made on a series of four 278-ft. (85 m.) lengths of 1,000,000-circ.mil concentric cables which had been installed in ducts between manholes, connected in series, with bends and splices to simulate actual conditions. The object was to determine loads, temperatures and expansion of cables at which the sheaths would crack if the cables were subjected to specified cycles of eight-hour load and sixteen-hour no-load for periods extending over two months. Temperatures of sheaths were taken by thermocouples and the inner copper temperatures calculated, using the Atkinson constant of thermal resistivity of 354, which had been independently checked and appeared to be approximately correct. In Fig. 1 are given the maximum temperatures for lead sheath and inner copper for the different thermocouple locations at a 1,250-amp. load. For one typical location it appears that the insulation withstood the temperatures specified in Table I.

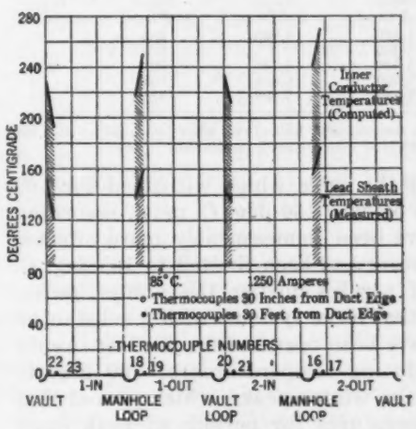


FIG. 1—EXCESSIVE TEMPERATURES AT WHICH 1,000,000-CIRC.MIL CONCENTRIC CABLES WERE TESTED

TABLE I—TIME SUMMARY OF HIGH TEMPERATURE TESTS

Inner Conductor Temperature, Deg. C.	Hours	Remarks
Less than 85	73	Hours of tests with current on —exclusive of hours of cooling with current off.
85—90	13	
90—100	26	
100—110	37	
110—125	88	
125—150	36	
Over 150	169	
Total duration of test periods..	442	

The sample of cable at this location showed its insulation to be in good condition, the inner insulation being darkened and of considerably reduced tensile strength

*"Temperature and Electrical Insulation," *A.I.E.E. Proceedings*, Vol. XXXII, 1913.

but yet in perfect condition for indefinite service, according to Mr. Torchio, notwithstanding the fact that the insulation operated at a temperature of over 110 deg. C. for 293 hours, of over 125 deg. for 205 hours and of over 150 deg. for 169 hours.

With the enormously high temperatures to which the cable was subjected, only 20 ft. (6 m.) of one length out of 1,112 ft. (340 m.) of cable had the insulation destroyed. The four lengths were removed from the ducts and reeled and rereeled in some instances twice, and after this handling the cable lengths were subjected to regular factory voltage and insulation tests, with the results shown in Table II.

TABLE II—RESULTS OF VOLTAGE AND INSULATION TESTS ON CABLES

		Voltage Tests Five-Minute Application		Insulation Test Megohms per Mile	
Section	No. of Times Re-reeled	Inner to Outer and Lead	Outer to Inner and Lead	Inner to Outer and Lead	Outer to Inner and Lead
1 in	1	5,400	5,900	460	184
1 out	2	5,400	*	770	...
		5,500	5,700	703	289
2 in	1	5,500	6,600	100	56
2 out	2	5,400	5,800	520	105

* Broke down 12 ft. from the end near hub of reel after two minutes at 6,000 volts. Remaining portion retested with results in second line "1 out."

The insulation of the cable which withstood for 169 hours temperatures of over 150 deg. C. must, according to Mr. Torchio, have been immeasurably more affected than if the temperature had been limited to 105 deg. C. for many years of service during the winter peaks. Mr. Torchio stated that large systems with a substantial number of cables have been operated for the last twenty years at loads producing temperatures of 100 deg. to 110 deg. C. during the winter peaks, which proved that these seasonal temperatures for periods of peak loads had not impaired the cable insulation for occasional withdrawal and reinstallation.

The hardening of oil in the insulation which takes place when temperatures of 100 deg. C. and over are sustained continuously will either not take place at temperatures of 105 deg. C. applied only for a short time for certain periods of the year, or if any hardening takes place, the process will extend over periods exceeding fifteen or twenty years. At the ends of these periods it is improbable that any substantial amount of such cable would be reinstalled, if removed; but if the lead sheath is intact, the tests on the sample cables which have been submitted to almost destructive temperatures have shown that the cable can still be reeled and rereeled without destroying its efficiency as regards both dielectric strength and insulation resistance. In practice, he believed, the aging and deterioration of the lead sheath due to chemical action, electrolysis and similar causes will be the paramount factor in the life of low-tension cables.

SHEATH CRACKING DUE TO HANDLING

The difficulties caused by lead sheaths cracking in large-sized cables are essentially problems of careful installation and handling of the cable. In the heavy load tests just described no cracking was produced under the extraordinarily severe conditions of temperatures which gave expansions as large as 8 in. (20 cm.) in 278 ft. (85 m.). In practice, with 105 deg. C. temperatures, the expansions in the lead sheaths would only be 3¼ in. (68.3 cm.).

The assertion has been made that the compound might distill or vaporize at temperatures of above 100 deg. C. An exhaustive investigation was made by the New York Edison Company to determine the effect of temperature on cable impregnating materials. The results of laboratory tests carried out by the Electrical Testing Laboratories indicated that the mineral compound gave the first drop of distillate at 205 deg. C. A supplementary investigation was made to determine if the compounds would distill any appreciable amount at temperatures below 200 deg. C. when exposed to these temperatures for long periods of time. No distillate, however, was obtained for either mineral or resin compounds after the temperature had been maintained successively at temperatures of 115, 130, 145 and 160 deg. C. for three days. Similar results were obtained when the temperature was maintained at 180 deg. and 200 deg. C. for twenty-four and thirty-six hours.

Before making the final recommendations the author brought out the point that the operator must carefully study the temperatures under which the cables will operate when placed in subway ducts, especially when the trunk lines contain many ducts and cables in one bank. The paramount importance of carefully surveying the ambient temperature conditions in ducts is shown in Fig. 2, giving the relative allowable losses for a given temperature rise on each cable with different duct arrangements. In the figure the losses in a bank of two by two ducts are assumed as 100 per cent, giving a standard for comparison.

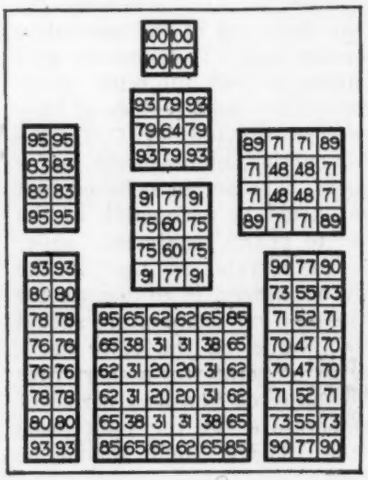


FIG. 2—PERMISSIBLE ENERGY LOSSES FOR VARIOUS DUCT POSITIONS FOR SAME TEMPERATURE RISE

OVERLOAD RATINGS ARE PROPOSED

In consideration of the foregoing data, including the Steinmetz and Lamme report, the British Engineering Standards Committee tests and the surveys of large operating companies, Mr. Torchio held that the permissible operating temperatures of impregnated paper insulation, in which dielectric stress is low, should be a function of the load factor at which the cable operates. The load factor for cables used in systems of distribution is intended to be the ratio between the yearly average load and the maximum load on the cable. He considered it certain that a load factor of say 33 per cent with seasonal winter peaks and correspondingly smaller maximum loads for the rest of the year would produce an average temperature on the cable considerably below 85 deg. C., so that a limit of say 105 deg. C. at peaks for 33 per cent load factors is safer than 85 deg. C. continuously, as allowed by the present A. I. E. E. rules. The proposed plan corresponds with the established practice of rating electrical apparatus at a temperature rise of say 40 deg. C. for continuous loads and from 55 deg. to 65 deg. C. for two or three hours' overload. Machinery so designed has given excellent service for the last twenty-five years.

The following temperature limits were offered for impregnated-paper, low-tension cables as functions of are load factor of the cable:

105 deg. C. for load factors around 33 per cent.
95 deg. C. for load factors around 50 per cent.
90 deg. C. for load factors over 66 per cent.

Temperature limits might perhaps be presented in a more general form by working back from the load factors to corresponding values of rise of temperature allowable for normal loads and overloads for specified hours, but Mr. Torchio preferred to use the load factors, as they are fundamental in the determination of the most economical current density in cables.

Australian Steam Station with a Rating of 125,000 Kw.

Will Burn 50-Cent Coal—All Electrical Equipment to Be Outdoors—132,000-Volt Transmission Line to Melbourne Will Have Five Towers per Mile

CONSTRUCTION of a 125,000-kw. steam plant 112 miles (180 km.) from Melbourne, Australia, will be immediately started, upon the closing of tenders on March 31, and the letting of contracts for the apparatus. The complete project includes the opening of extensive coal fields adjacent to the generating station site, the construction of a generating plant containing five units, each rated at 25,000 kw., the building of a total of 1,800 miles (2,900 km.) of 132,000-volt transmission line and the construction of three terminal substations.

At the present time the city of Melbourne has one 22,000-kw. steam station operated by the City Council, one 22,000-kw. steam station operated by a private company and one 78,000-kw. steam station operated by the state government. The latter is for supplying the railways. The new project is to be built and operated by the electricity commissioners of the government of Victoria and will sell energy in bulk to the present distribution utilities and also in the surrounding districts. No secondary distribution will be undertaken by the electricity commissioners.

Coal for the new station, which will be known as Morwell, will be obtained from fields immediately surrounding the power house. In 1 sq.mile (2 sq.km.) of these coal fields there is sufficient coal to operate the new power house for 150 years. There are 60 sq.miles (153.4 sq.km.) of these coal beds in the vicinity of this steam station. The coal bears an overburden of 33 ft. (10 m.) and the seam is 273 ft. (83 m.) thick. The coal will be mined by stripping and can be delivered to the power house at a cost of approximately 50 cents a ton. As the cost of fuel will be so low, no economizers are planned for the station.

A river alongside the power house will supply condensing water, but the flow of this river will place a limit on the size of the station unless use is made of spray cooling ponds.

The boiler plant and engine room are to be placed in one building. A second building will house the control apparatus and offices. Between the latter building and the generating station proper will be the 400-volt auxiliary transformers, the 400-volt buses and switch gear. Beyond the control building will be the main 11,000-volt low-tension buses, the step-up transformers, the high-tension switches and the 132,000-volt high-tension buses. The generators will operate at 50 cycles, 11,000 volts. Single-phase transformers rated at 9,260 kva. will step up the voltage to 132,000 volts for transmission.

The transmission line will consist of two two-circuit steel-tower lines having the towers spaced from 1,056 ft. to 1,500 ft. (322 m. to 457 m.). Dead-end towers will be placed 7 miles to 10 miles (11 km. to 16 km.) apart, and semi-anchor towers will be placed about every mile (1.6 km.). This rather long spacing between towers has been selected for the purpose of reducing the number of insulators to be used on the line, and it has been determined to be the most economical spacing for this particular installation. The three wires of one circuit will be placed in a vertical position with 11 ft. (3.35 m.) between conductors.

PARTICULARS OF 132,000-VOLT LINE

The climatic conditions are very favorable indeed. No high elevations whatever are encountered, and there is no fog, sleet or snow and comparatively little lightning. Seven suspension units will be used in suspension strings and eight units in dead ends. The line is designed for the use of an overhead ground wire on each tower line. A telephone line will be constructed on a separate pole line. At each of the terminal substations there will be two 15,000-kva. synchronous condensers which will be connected on 6,600-volt tertiary delta windings on the main step-down transformers. At the generating station end the transformers are to be connected delta-star with the neutral grounded. At the terminal stations end the transformers will be connected star-star and the neutral grounded through resistance. The terminal-station transformers will step down the voltage from 120,000 to 22,000 volts for distribution. The transmission lines will be operated at the constant voltage of 132,000 volts at the generating station and 120,000 volts at the terminal substation. Each line is designed for an economical capacity of 25,000 kw. By an interlocking of the line and tie switches at the terminal stations, should one transmission line fail the tie switch between the high-tension sides of the step-down transformers will immediately close, thereby placing the two 15,000-kva. synchronous condensers on the one remaining line, which will permit it to transmit 42,500 kw. at the same voltage drop as with 25,000 kw. transmitted and one 15,000-kva. synchronous condenser operating on it. With the two condensers operating on one line, 50,000 kw. may be transmitted over this line by raising the transmission-line voltage at the generating station 5 per cent, from 132,000 volts to 138,000 volts. Under these conditions the transmission-line voltage at the terminal station will be 120,000 volts, as normally.

The terminal substations will be separated 8 miles (12.8 km.). Two of the transmission circuits will enter each terminal substation. It was found that the least expense would be to utilize three terminal stations rather than to have the four transmission lines enter one station and make the entire distribution by underground cables operating at 22,000 volts. The cost per mile of the transmission line will be approximately $15,000, while underground cable for the same carrying capacity would cost $300,000 per mile. There are to be nine substations in Melbourne. There will be approximately 80 miles (128 km.) of 22,000-volt underground cable in the city interconnecting the nine substations.

Table I—Recommended Standards of Illumination

	Foot-Candles	
	Recommended	Under Some Conditions
Auditorium church	3	2– 4
Armory, public hall	5	3– 6
School—class room, study room, library	8	5–10
Store:		
Show window	10–70	.....
First-floor department, shop on bright street corner	10	6–12
Other clothing, dry goods, haberdashery, millinery, jewelry, etc.	8	5–10
Other drug, grocery, meat, bakery, book, florist, furniture, lunch room, confectionery, etc.	6	4– 8
Office:		
Private general	10	6–12
Drafting room	15	10–20
Industrial:		
Aisles, stairways, passageways and corridors	2	1– 2
Assembling:		
Rough	5	3– 6
Medium	8	5–10
Fine	10	6–12
Extra fine	10–50	.....
Bakeries	8	5–10
Boilers, engine rooms and power houses:		
Boilers, coal and ash handling, storage-battery rooms	3	2– 4
Auxiliary equipment, oil switches and transformers	5	3– 6
Switchboards, engines, generators, blowers, compressors	6	4– 8
Candy making	8	5–10
Canning and preserving	8	5–10
Chemical works:		
Hand furnaces, boiling tanks, stationary driers, stationary or gravity crystallizing	3	2– 4
Mechanical furnaces, generators and stills, mechanical driers, evaporators, filtration, mechanical crystallizing, bleaching	4	3– 6
Tanks for cooking, extractors, percolators, nitrators, electrolytic cells	6	4– 8
Clay products and cements:		
Grinding, filter presses, kiln rooms	3	2– 4
Molding, pressing, cleaning and trimming	5	3– 6
Enameling	6	4– 8
Coloring and glazing	10	6–12
Cloth products:		
Light goods	10	6–12
Dark goods	15	10–20
Dairy products	6	4– 8
Electric manufacturing:		
Storage battery, molding of grids	6	4– 8
Coil and armature winding, mica working, insulating processes	10	6–12
Elevator, freight and passenger	5	3– 6
Forge shops and welding:		
Rough forging	6	4– 8
Fine forging and welding	10	6–12
Foundries:		
Charging floor, tumbling, cleaning, pouring and shaking out	5	3– 6
Rough molding and core making	6	4– 8
Fine molding and core making	10	6–12
Glass works:		
Mix and furnace rooms, casting and lehr	5	3– 6
Grinding, glass blowing machines, cutting glass to size, silvering	8	5–10
Fine grinding, polishing, beveling, inspecting, etching and decorating	10	6–12
Glass cutting (cut glass), inspecting fine	10–50	.....
Glove manufacturing:		
Light goods:		
Cutting, pressing, knitting	8	5–10
Sorting, stitching, trimming and inspecting	10	6–12
Dark goods:		
Cutting, pressing, knitting	10	6-12
Sorting, stitching, trimming and inspecting	10–50	.....
Hat manufacturing:		
Dyeing, stiffening, braiding, cleaning and refining:		
Light	6	4– 8
Dark	10	6–12
Forming, sizing, pouncing, flanging, finishing and ironing:		
Light	8	5–10
Dark	10	6–12
Sewing:		
Light	10	6–12
Dark	10–50	.....
Ice making:		
Engine and compressor room	6	4– 8
Inspecting:		
Rough	6	4– 8
Medium	10	6–12
Fine	15	10–20
Extra fine	10–50	.....
Jewelry and watch manufacturing	10–50	.....
Laundries and dry cleaning	8	5–10
Leather manufacturing:		
Vats	3	2– 4
Cleaning, tanning and stretching	4	3– 6
Cutting, fleshing and stuffing	6	4– 8
Finishing and scarfing	10	6–12
Leather working:		
Pressing and winding:		
Light	8	5–10
Dark	10	6–12
Grading, matching, cutting, scarfing, sewing:		
Light	10	6–12
Dark	10–50	.....
Locker rooms	4	2– 4
Machine shops:		
Rough bench and machine work	6	4– 8
Medium bench and machine work, ordinary automatic machines, rough grinding, medium buffing and polishing	10	6–12
Fine bench and machine work, fine automatic machines, medium grinding, fine buffing and polishing	12	8–16
Extra fine bench and machine work, grinding (fine work)	10–50	.....
Meat packing:		
Slaughtering	5	3– 6
Cleaning, cutting, cooking, grinding, canning and packing	8	5–10
Milling and grain foods:		
Cleaning, grinding or rolling	5	3– 6
Baking or roasting	8	5–10
Packing:		
Rough	4	3– 6
Medium	6	4– 8
Fine	10	6–12
Paint manufacturing	6	4– 8
Paint shops:		
Dipping, spraying, firing	5	3– 6
Rubbing, ordinary hand painting and finishing	8	5–10
Fine hand painting and finishing	10	6–12
Extra-fine hand painting and finishing (automobile bodies, piano cases, etc.)	15	10–50
Paper-box manufacturing:		
Light	6	4– 8
Dark	8	5–10
Paper manufacturing:		
Beaters, machine grinding	4	3– 6
Calendering	6	4– 8
Finishing, cutting and trimming	8	6–12
Plating	5	3 6
Polishing and burnishing	8	5–10
Printing industries:		
Matrixing and casting, miscellaneous machines, presses	8	5–10
Proofreading, lithographing, electrotyping	10	6–12
Linotype, monotype, typesetting, imposing stone, engraving	10–50	.....
Receiving and shipping	4	3– 6
Rubber manufacturing and products:		
Calendars, compounding mills, fabric preparation, stock cutting, tubing machines, solid-tire operations, mechanical goods building, vulcanizing	8	5–10
Bead building, pneumatic tire building and finishing, inner tube operation, mechanical goods, trimming, treading	10	6–12
Sheet metal works:		
Miscellaneous machines, ordinary bench work, Punches, presses, shears, stamps, welders, spinning, fine bench work	8	5-10
	10	6–12
Shoe manufacturing:		
Hand turning, miscellaneous bench and machine work	8	5–10
Inspecting and sorting raw material, cutting, lasting and welding (light)	10	6–12
Inspecting and sorting raw material, cutting, stitching (dark)	10–50	.....
Soap manufacturing:		
Kettle houses, cutting, soap chip and powder	5	3-6
Stamping, wrapping and packing, filling and packing soap powder	6	4-8
Steel and iron mills, bar, sheet and wire products:		
Soaking pits and reheating furnaces	2	1– 2
Charging and casting floors	3	2– 4
Muck and heavy rolling, shearing, rough by gage, pickling and cleaning	4	3– 6
Automatic machines, rod, light and cold rolling, wire drawing, shearing, fine by line	6	4– 8
Store and stock rooms:		
Rough	3	2– 4
Medium	6	4– 8
Fine	8	5–10
Structural steel fabrication	6	4– 8
Textile mills:		
(Cotton)		
Opening and lapping, carding, drawing frame roving, dyeing	4	3– 6
Spooling, spinning, drawing in, warping, weaving, quilling, inspecting, knitting, slashing	8	5–10
(Silk)		
Winding, throwing, dyeing	8	5–10
Quilling, warping, weaving and finishing:		
Light goods	8	5–10
Dark goods	10	6–12
(Woolen)		
Carding, picking, washing and combing	4	3– 6
Twisting and dyeing	6	4– 8
Drawing in, warping:		
Light goods	6	4– 8
Dark goods	10	6–12
Weaving		
Light goods	8	5–10
Dark goods	12	8–16
Knitting machines	10	6–12
Tobacco products	8	5–10
Toilet and wash rooms	4	3– 6
Wood working:		
Rough sawing and bench work	5	3– 6
Sizing, planing, rough sanding, medium machine and bench work, gluing, veneering, cooperage	8	5–10
Fine and bench and machine working, fine sanding and finishing	10	6–12

(Accompanying "Illumination Design Simplified," page 417)

Illumination Design Simplified

Planning a System Is Divided Into Four Main Steps — Reflecting Equipment Selected on the Basis of Seven Comparative Factors—Room Index a New Key by Which Variable Factors May Be Allowed For

By EARL A. ANDERSON
Engineering Department, National Lamp Works of General Electric Company

MODERN LIGHTING DESIGN INVOLVES A CONSIDERATION OF ALL FACTORS TO INSURE A SUCCESSFUL INSTALLATION

IN THE design of modern commercial and industrial lighting systems a large number of variable factors must be considered, such as choice of reflecting equipment, allowable spacing, the coefficients of utilization in different sizes and types of interiors, depreciation factor, etc., if the quantity and quality of the illumination desired is to be obtained. To take into account all of these important factors has seemed so complicated a task that many designers still adhere to rule-of-thumb methods which are likely to result in unsatisfactory installations, especially where the conditions depart from the ordinary. With a view to simplifying the work of accurately laying out lighting systems, the data in this article have been compiled. Through their use it is possible to plan a system meeting all the modern requirements and taking into consideration all of the factors in such a way that allowance will be made for varying types of installation.

To arrive at a logical solution of the lighting problem the design may be divided into four principal steps:

1. The decision as to the foot-candles of illumination required.
2. The selection of a lighting unit best adapted to the particular requirements.
3. The determination of outlet locations, mounting height and number of lighting units required.
4. The selection of the proper size of lamp to provide the foot-candles desired.

There has been such a rapid advance in lighting standards, almost from month to month, that intensity tables are obsolescent before they are published. In Table I, however, a list of foot-candle values is presented corresponding to present standards for different classes of industrial operations, offices, stores, etc.

The desirable illumination varies rather widely, depending on the conditions in any particular installation, such as accuracy of the operation and fineness of detail to be observed, the color of goods worked on or handled, and, in the case of stores, the advertising value resulting from the attractiveness of a well-lighted interior. The foot-candle values recommended in the table are the minimum to be adhered to if fully satisfactory lighting is to be assured. Under particular conditions considerably higher illumination is often desirable.

SELECTION OF LIGHTING UNITS VERY IMPORTANT

The selection of the type of lighting unit depends not only upon the requirements of the work, but in some cases upon the construction of the room and the color of ceiling and walls. For example, semi-indirect and totally indirect lighting are unsuited to rooms with very dark ceilings. It is important to specify the type of lamp to be used, since, for example, as shown in Fig. 1, bowl-enameled lamps used in open reflectors, such as RLM standard domes, form a lighting unit much superior from the standpoint of glare, reflected glare and shadows to clear lamp units of the same type. In general, clear gas-filled tungsten lamps (type C) should not be used in open reflectors where the mounting height is less than 20 ft. (6 m.).

Factors other than those listed in Fig. 1 may enter

Direct Lighting-SOURCES 5 FEET ABOVE WORK PLANE

ROOM WIDTH	ROOM LENGTH—FEET																			
	10	12	14	16	18	20	24	30	35	40	50	60	70	80	100	120	140	170	200
8	0.8	0.8	1.0	1.0	1.0	1.0	1.25	1.25	1.25	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
10	1.0	1.0	1.0	1.25	1.25	1.25	1.25	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
12	1.0	1.25	1.25	1.25	1.25	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
14	1.0	1.25	1.5	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
16	1.25	1.25	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
18	1.25	1.25	1.5	1.5	2.0	2.0	2.0	2.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
20	1.25	1.5	1.5	1.5	2.0	2.0	2.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
24	1.25	1.5	1.5	2.0	2.0	2.0	2.5	2.5	2.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
30	1.5	1.5	2.0	2.0	2.0	2.5	2.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
35	1.5	1.5	2.0	2.0	2.5	2.5	2.5	3.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
40	1.5	2.0	2.0	2.0	2.5	2.5	3.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
50	1.5	2.0	2.0	2.0	2.5	2.5	3.0	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
60	1.5	2.0	2.0	2.0	2.5	2.5	3.0	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
70	1.5	2.0	2.0	2.0	2.5	2.5	3.0	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
80	1.5	2.0	2.0	2.0	2.5	2.5	3.0	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
100	1.5	2.0	2.0	2.0	2.5	2.5	3.0	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
120	1.5	2.0	2.0	2.0	2.5	2.5	3.0	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0

Semi and Indirect Lighting-CEILING 7½ FEET ABOVE WORK PLANE

Direct Lighting-SOURCES 6 FEET ABOVE WORK PLANE

ROOM WIDTH	ROOM LENGTH—FEET																			
	10	12	14	16	18	20	24	30	35	40	50	60	70	80	100	120	140	170	200
8	0.8	0.8	0.8	0.8	0.8	1.0	1.0	1.0	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
10	0.8	0.8	1.0	1.0	1.0	1.0	1.25	1.25	1.25	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
12	0.8	1.0	1.0	1.0	1.25	1.25	1.25	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
14	1.0	1.0	1.25	1.25	1.25	1.25	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
16	1.0	1.0	1.25	1.25	1.25	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
18	1.0	1.25	1.25	1.25	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
20	1.0	1.25	1.25	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
24	1.25	1.25	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
30	1.25	1.5	1.5	2.0	2.0	2.0	2.5	2.5	2.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
35	1.25	1.5	1.5	1.5	2.0	2.0	2.0	2.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
40	1.5	1.5	1.5	2.0	2.0	2.0	2.5	2.5	3.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
50	1.5	1.5	2.0	2.0	2.0	2.5	2.5	3.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
60	1.5	1.5	2.0	2.0	2.0	2.5	2.5	3.0	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
70	1.5	1.5	2.0	2.0	2.0	2.5	2.5	3.0	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
80	1.5	1.5	2.0	2.0	2.0	2.5	2.5	3.0	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
100	1.5	1.5	2.0	2.0	2.0	2.5	2.5	3.0	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
120	1.5	1.5	2.0	2.0	2.0	2.5	2.5	3.0	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0

Semi and Indirect Lighting-CEILING 9 FEET ABOVE WORK PLANE.

Direct Lighting-SOURCES 7 FEET ABOVE WORK PLANE

ROOM WIDTH	ROOM LENGTH—FEET																			
	10	12	14	16	18	20	24	30	35	40	50	60	70	80	100	120	140	170	200
8	0.6	0.6	0.6	0.6	0.8	0.8	0.8	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
10	0.6	0.8	0.8	0.8	0.8	0.8	1.0	1.0	1.0	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
12	0.8	0.8	0.8	0.8	1.0	1.0	1.0	1.25	1.25	1.25	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
14	0.8	0.8	1.0	1.0	1.0	1.0	1.25	1.25	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
16	0.8	0.8	1.0	1.25	1.25	1.25	1.25	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
18	0.8	1.0	1.0	1.25	1.25	1.25	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
20	1.0	1.0	1.0	1.25	1.25	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
24	1.0	1.0	1.25	1.25	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
30	1.0	1.25	1.25	1.5	1.5	1.5	2.0	2.0	2.5	2.5	2.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
35	1.0	1.25	1.5	1.5	1.5	1.5	2.0	2.0	2.5	2.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
40	1.25	1.25	1.5	1.5	1.5	2.0	2.0	2.5	2.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
50	1.25	1.5	1.5	1.5	2.0	2.0	2.0	2.5	3.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
60	1.25	1.5	1.5	2.0	2.0	2.0	2.5	2.5	3.0	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
70	1.25	1.5	1.5	2.0	2.0	2.0	2.5	3.0	3.0	3.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
80	1.25	1.5	1.5	2.0	2.0	2.0	2.5	3.0	3.0	3.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
100	1.25	1.5	1.5	2.0	2.0	2.0	2.5	3.0	3.0	3.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
120	1.25	1.5	1.5	2.0	2.0	2.0	2.5	3.0	3.0	3.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0

Semi and Indirect Lighting-CEILING 10½ FEET ABOVE WORK PLANE

Direct Lighting-SOURCES 8 FEET ABOVE WORK PLANE

ROOM WIDTH	ROOM LENGTH—FEET																			
	10	12	14	16	18	20	24	30	35	40	50	60	70	80	100	120	140	170	200
8	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
10	0.6	0.6	0.6	0.6	0.8	0.8	0.8	0.8	1.0	1.0	1.0	1.0	1.25	1.25	1.25	1.25	1.25	1.25	1.25
12	0.6	0.8	0.8	0.8	0.8	0.8	1.0	1.0	1.0	1.25	1.25	1.25	1.25	1.5	1.5	1.5	1.5	1.5	1.5
14	0.6	0.8	0.8	1.0	1.0	1.0	1.0	1.25	1.25	1.25	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
16	0.6	0.8	1.0	1.0	1.0	1.0	1.25	1.25	1.25	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0
18	0.8	0.8	1.0	1.0	1.0	1.25	1.25	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
20	0.8	0.8	1.0	1.0	1.25	1.25	1.25	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
24	0.8	1.0	1.0	1.0	1.25	1.25	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
30	0.8	1.0	1.0	1.25	1.25	1.5	1.5	2.0	2.0	2.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
35	1.0	1.0	1.25	1.25	1.5	1.5	1.5	2.0	2.0	2.5	2.5	2.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0
40	1.0	1.25	1.25	1.5	1.5	1.5	2.0	2.5	2.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
50	1.0	1.25	1.25	1.5	1.5	2.0	2.0	2.5	3.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
60	1.0	1.25	1.5	1.5	1.5	2.0	2.0	2.5	2.5	3.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
70	1.25	1.25	1.5	1.5	2.0	2.0	2.0	2.5	3.0	3.0	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0
80	1.25	1.5	1.5	2.0	2.0	2.0	2.0	2.5	3.0	3.0	3.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
100	1.25	1.5	1.5	2.0	2.0	2.0	2.0	2.5	3.0	3.0	3.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
120	1.25	1.5	1.5	2.0	2.0	2.0	2.0	2.5	3.0	3.0	3.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0

Semi and Indirect Lighting-CEILING 12 FEET ABOVE WORK PLANE

Direct Lighting-SOURCES 10 FEET ABOVE WORK PLANE

ROOM WIDTH	ROOM LENGTH—FEET																			
	10	12	14	16	18	20	24	30	35	40	50	60	70	80	100	120	140	170	200
8		0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	0.8	1.0	1.0	1.0	1.0	1.0
10	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0
12	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	0.8	0.8	1.0	1.0	1.0	1.25	1.25	1.25	1.25	1.25	1.25
14	0.6	0.6	0.6	0.8	0.8	0.8	0.8	0.8	1.0	1.0	1.0	1.25	1.25	1.25	1.5	1.5	1.5	1.5	1.5
16	0.6	0.6	0.8	0.8	0.8	0.8	0.8	1.0	1.0	1.0	1.25	1.25	1.25	1.5	1.5	1.5	1.5	1.5	1.5
18	0.6	0.6	0.8	0.8	0.8	1.0	1.0	1.0	1.0	1.25	1.25	1.25	1.5	1.5	1.5	1.5	1.5	1.5	1.5
20	0.6	0.8	0.8	0.8	1.0	1.0	1.0	1.25	1.25	1.25	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
24	0.6	0.8	0.8	0.8	1.0	1.0	1.25	1.25	1.25	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0
30	0.6	0.8	0.8	1.0	1.0	1.25	1.25	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
35	0.8	0.8	1.0	1.0	1.0	1.25	1.25	1.5	1.5	2.0	2.0	2.0	2.0	2.5	2.5	2.5	2.5	2.5	2.5
40	0.8	0.8	1.0	1.0	1.25	1.25	1.5	1.5	2.0	2.0	2.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
50	0.8	1.0	1.0	1.25	1.25	1.5	1.5	1.5	2.0	2.0	2.5	2.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0
60	0.8	1.0	1.25	1.25	1.25	1.5	1.5	2.0	2.0	2.5	2.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
70	1.0	1.0	1.25	1.25	1.5	1.5	1.5	2.0	2.0	2.5	3.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
80	1.0	1.25	1.25	1.5	1.5	1.5	2.0	2.0	2.5	2.5	3.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
100	1.0	1.25	1.5	1.5	1.5	1.5	2.0	2.0	2.5	2.5	3.0	4.0	4.0	4.0	4.0	5.0	5.0	5.0	5.0
120	1.0	1.25	1.5	1.5	1.5	1.5	2.0	2.0	2.5	2.5	3.0	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0

Semi and Indirect Lighting-CEILING 15 FEET ABOVE WORK PLANE

Direct Lighting-SOURCES 14 FEET ABOVE WORK PLANE

ROOM WIDTH	ROOM LENGTH—FEET																			
	10	12	14	16	18	20	24	30	35	40	50	60	70	80	100	120	140	170	200
8							0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	0.8	0.8	0.8
10						0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	0.8	0.8	0.8	0.8
12					0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
14			0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	0.8	0.8	1.0	1.0	1.0	1.0
16			0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0
18	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	0.8	1.0	1.0	1.0	1.0	1.25	1.25	1.25	1.25
20	0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	0.8	1.0	1.0	1.0	1.25	1.25	1.25	1.25	1.25	1.25
24	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	1.0	1.0	1.0	1.25	1.25	1.25	1.5	1.5	1.5	1.5	1.5
30	0.6	0.6	0.6	0.6	0.8	0.8	0.8	1.0	1.0	1.25	1.25	1.25	1.5	1.5	1.5	2.0	2.0	2.0	2.0
35	0.6	0.6	0.6	0.6	0.8	0.8	1.0	1.0	1.25	1.25	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0
40	0.6	0.6	0.6	0.8	0.8	1.0	1.0	1.25	1.25	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0
50	0.6	0.6	0.8	0.8	1.0	1.0	1.25	1.5	1.5	1.5	2.0	2.0	2.0	2.5	2.5	2.5	2.5	2.5	2.5
60	0.6	0.8	0.8	0.8	1.0	1.0	1.25	1.25	1.5	1.5	2.0	2.0	2.0	2.5	2.5	2.5	3.0	3.0	3.0
70	0.8	0.8	0.8	1.0	1.0	1.0	1.25	1.5	1.5	1.5	2.0	2.0	2.5	2.5	3.0	3.0	3.0	3.0	3.0
80	0.8	0.8	0.8	1.0	1.0	1.25	1.25	1.5	1.5	2.0	2.0	2.5	2.5	3.0	3.0	3.0	3.0	3.0	3.0
100	0.8	0.8	0.8	1.0	1.0	1.25	1.5	1.5	2.0	2.0	2.5	2.5	3.0	3.0	4.0	4.0	4.0	4.0	4.0
120	0.8	0.8	1.0	1.0	1.25	1.25	1.5	1.5	2.0	2.0	2.5	2.5	3.0	3.0	4.0	4.0	5.0	5.0	5.0

Semi and Indirect Lighting-CEILING 21 FEET ABOVE WORK PLANE

Direct Lighting-SOURCES 20 FEET ABOVE WORK PLANE

ROOM WIDTH	ROOM LENGTH—FEET																			
	10	12	14	16	18	20	24	30	35	40	50	60	70	80	100	120	140	170	200
8																			
10										0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	0.8
12									0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	0.8
14									0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	1.0
16								0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	1.0	1.0
18							0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	1.0	1.0	1.0
20						0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	1.0	1.0	1.0	
24					0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	0.8	0.8	1.0	1.0	1.0	1.25	1.25
30				0.6	0.6	0.6	0.6	0.8	0.8	0.8	1.0	1.0	1.0	1.0	1.0	1.25	1.25	1.25	1.5
35		0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.8	1.0	1.0	1.0	1.0	1.25	1.25	1.25	1.5	1.5	1.5
40	0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.8	1.0	1.0	1.0	1.25	1.25	1.25	1.5	1.5	1.5	1.5	1.5
50	0.6	0.6	0.6	0.6	0.6	0.6	0.8	1.0	1.0	1.0	1.25	1.25	1.5	1.5	1.5	2.0	2.0	2.0	2.0
60	0.6	0.6	0.6	0.6	0.6	0.6	0.8	1.0	1.0	1.25	1.25	1.5	1.5	1.5	2.0	2.0	2.0	2.5	2.5
70	0.6	0.6	0.6	0.6	0.6	0.8	0.8	1.0	1.0	1.25	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.5	2.5
80	0.6	0.6	0.6	0.6	0.8	0.8	0.8	1.0	1.25	1.25	1.5	1.5	2.0	2.0	2.0	2.5	2.5	2.5	2.5
100	0.6	0.6	0.6	0.8	0.8	0.8	1.0	1.0	1.25	1.5	1.5	1.5	2.0	2.0	2.5	2.5	3.0	3.0	3.0
120	0.6	0.6	0.8	0.8	0.8	0.8	1.0	1.25	1.25	1.5	1.5	2.0	2.0	2.5	2.5	3.0	3.0	3.0	3.0

Semi and Indirect Lighting-CEILING 30 FEET ABOVE WORK PLANE

Direct Lighting-SOURCES 30 FEET ABOVE WORK PLANE

ROOM WIDTH	ROOM LENGTH—FEET																			
	10	12	14	16	18	20	24	30	35	40	50	60	70	80	100	120	140	170	200
8																			
10																			
12																			
14																			
16											0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.8
18											0.6	0.6	0.6	0.6	0.6	0.6	0.6	0

into the choice of the lighting unit in certain instances. For example, in stores, offices and other public installations decorative effect is often an important item. The charts rate the various types of units comparatively to serve as a basis for judgment of the adaptability of a unit for a particular class of installation.

In the selection of the reflecting equipment for a lighting system seven fundamentals must be taken into account, namely:

1. *Illumination on Horizontal Surfaces.*—This is a prime requisite in offices, drafting rooms and those shops where the problem is to provide the best illumination for sustained vision of flat surfaces on the horizontal or slightly oblique planes in which papers, books and other flat objects are usually examined.

2. *Illumination on Vertical Surfaces.*—Such illumination in the case of work or machine parts is fully as important as the lighting of the surface in the horizontal plane. In a consideration of the amount of light necessary for factory illumination the criterion must be the intensity on all working surfaces, whether vertical, horizontal or oblique.

3. *Favorable Appearance of Lighted Room.*—Reference under this head is only to the general or casual effect produced by the complete system, and it is not intended to rate the unit as to satisfaction from the standpoint of good vision or freeedom from eye fatigue.

4. *Direct Glare.*—The most frequent and serious cause of bad lighting. It results, among other things, from unshaded or inadequately shaded light sources located within the field of vision, or from too great contrast between the bright light source and a dark background or adjacent surfaces. Glare should be avoided by the use of proper reflecting and diffusing equipment.

5. *Reflected Glare.*—Reflected glare from a polished working surface is particularly annoying because of the necessity of directing the eyes toward those surfaces, and further because the eyes are by nature especially sensitive to light rays from below. The harmful effects of this specular reflection can be minimized by properly shielding from below or diffusing the source.

6. *Shadows.*—Differences in brightness of surfaces are essential in observing objects in their three dimensions but are of little or no value in the observation of flat surfaces. Where shadows are desirable they should be soft and luminous, not so sharp and dense as to confuse the object with its shadow.

7. *Maintenance.*—Maintenance depends upon contour of reflector, construction of fixture and condition of ceiling. The rating is based upon the likelihood of breakage, the labor involved in maintaining the units at comparable degrees of efficiency, and the indication given of need of cleaning.

Relative importance of the foregoing criteria should be very carefully weighed with respect to the particular problem at hand. For instance, in an office the points would rank thus in importance: (1) Direct glare; (2) reflected glare; (3) shadows; (4) efficiency based upon illumination on horizontal; (5) main-

	LIGHTING UNIT	EFFICIENCY BASED UPON: ILLUMINATION ON HORIZONTAL	EFFICIENCY BASED UPON: ILLUMINATION ON VERTICAL	FAVORABLE APPEARANCE OF LIGHTED ROOM	DIRECT GLARE	REFLECTED GLARE	SHADOWS	MAINTENANCE
1	R L M DOME	A+	B+	C+	C	D	C+	A+
2	R L M DOME	A−	B	B	B+	B	B+	A−
3	GLASS TOP DOME	B	C+	A−	A−	B	B+	B
4	DEEP DOME	B+	B−	C	C+	D	C	A
5	DEEP DOME	B	C+	C	B	C+	C+	B+
6	FLAT CONE	B	C+	C+	C+	D	C	B+
7	FLAT CONE	B	B	C	D	D	C	A+
8	LIGHT DENSITY OPAL	B+	B	B+	C+	D	B−	B
9	LIGHT DENSITY OPAL	B	B−	A−	B−	B−	B+	B−
10	DENSE OPAL	A+	B+	B+	B	D	C+	A−
11	DENSE OPAL	B+	B−	A−	B+	B−	B	B
12	MARBLED GLASS	A	B	C	C+	D	C	A−
13	MARBLED GLASS	B	C+	C	B−	C	C+	B−
14	PRISMATIC INDIRECT	A+	A−	B+	C+	D	C+	B−

	LIGHTING UNIT	EFFICIENCY BASED UPON: ILLUMINATION ON HORIZONTAL	EFFICIENCY BASED UPON: ILLUMINATION ON VERTICAL	FAVORABLE APPEARANCE OF LIGHTED ROOM	DIRECT GLARE	REFLECTED GLARE	SHADOWS	MAINTENANCE
15	DIFFUSING GLOBE	B−	B−	A	B−	B	B+	B+
16	ONE PIECE OPAL	B	B	A	B	B	B+	A−
17	DIFFUSING GLOBE	B	B	B+	B	B	B+	B+
18	SEMI ENCLOSING	B	B	A	B	B	B+	B−
19	SEMI ENCLOSING	B	B	A	A	A−	A−	C+
20	TWO PIECE GLASS	B	B	A	B+	B+	A−	B
21	ONE PIECE GLASS	B	B	A	B+	B+	A−	A−
22	LIGHT OPAL	B−	C+	A	B+	B+	A−	C
23	DENSE OPAL	C+	C	A	A+	A	A+	C
24	ENAMELED METAL REFLECTOR	B−	C	A	A	B+	B+	C
25	ENAMELED METAL REFLECTOR	C+	C	A	A+	A	A	C
26	CLEAR TOP ENCLOSING	C+	C	A	A+	A	A	B
27	MARBLED INDIRECT	C+	C	B+*	A+	A	A+	C
28	ENAMELED METAL INDIRECT	C	C	B+	A+	A	A+	C

*For Luminous Bowl Type Rate A.

FIG. 1—REFLECTOR EQUIPMENT MAY BE SELECTED ON A BASIS OF CHARACTERISTICS

DIRECT LIGHTING PORCELAIN ENAMEL REFLECTORS

	Reflector Type	Room Index	Very Light (75%) Ceiling / Fairly Dark (30%) Walls	Very Light (75%) Ceiling / Fairly Dark (30%) Walls	Very Light (75%) Ceiling / Very Dark (10%) Walls	Fairly Light (50%) Ceiling / Fairly Dark (30%) Walls	Fairly Light (50%) Ceiling / Very Dark (10%) Walls	Fairly Dark (30%) Ceiling / Fairly Dark (30%) Walls	Fairly Dark (30%) Ceiling / Very Dark (10%) Walls
			Coefficients of Utilization						
1	D L W Dome, Clear Lamp; 90° to 100°—6%; 0° to 90°—26%	0.6	.34	.29	.24	.34	.29	.24	.28	.24
		0.8	.42	.38	.34	.42	.37	.33	.37	.33
		1.0	.46	.43	.39	.45	.42	.39	.42	.39
		1.25	.50	.47	.43	.49	.46	.43	.45	.42
		1.5	.53	.50	.46	.52	.49	.46	.48	.45
		2.0	.58	.55	.51	.57	.54	.51	.53	.51
		2.5	.62	.59	.56	.61	.58	.56	.58	.56
		3.0	.64	.61	.58	.63	.60	.58	.60	.58
		4.0	.67	.65	.63	.66	.64	.62	.63	.61
		5.0	.69	.67	.65	.67	.66	.64	.65	.63
2	D L W Dome, Bowl-Enameled Lamp; 90° to 100°—6%; 0° to 90°—40%	0.6	.32	.28	.25	.32	.28	.25	.27	.25
		0.8	.40	.36	.34	.39	.35	.33	.35	.33
		1.0	.43	.39	.37	.42	.39	.37	.39	.37
		1.25	.46	.43	.41	.45	.43	.41	.43	.41
		1.5	.48	.45	.43	.47	.45	.43	.45	.43
		2.0	.52	.50	.48	.51	.49	.47	.49	.47
		2.5	.56	.54	.52	.55	.53	.51	.53	.51
		3.0	.57	.55	.53	.56	.54	.52	.54	.52
		4.0	.60	.58	.56	.59	.57	.55	.57	.55
		5.0	.61	.59	.57	.60	.58	.57	.58	.56
3	Glass Top Dome, Bowl-Enameled Lamp; 90° to 100°—4%; 0° to 90°—30%	0.6	.28	.25	.22	.27	.24	.22	.23	.21
		0.8	.34	.31	.29	.33	.30	.28	.30	.28
		1.0	.38	.35	.33	.36	.34	.32	.33	.32
		1.25	.41	.38	.36	.39	.37	.35	.36	.35
		1.5	.43	.40	.38	.41	.39	.37	.38	.37
		2.0	.47	.44	.42	.45	.43	.41	.41	.40
		2.5	.50	.47	.45	.48	.46	.44	.44	.43
		3.0	.51	.49	.47	.49	.47	.46	.46	.45
		4.0	.53	.51	.50	.51	.49	.48	.48	.47
		5.0	.55	.53	.51	.52	.50	.49	.49	.48
4	Deep Bowl, Clear Lamp; 90° to 100°—6%; 0° to 90°—65%	0.6	.31	.26	.23	.30	.26	.23	.25	.23
		0.8	.38	.34	.31	.37	.34	.31	.33	.31
		1.0	.41	.38	.35	.41	.38	.35	.37	.35
		1.25	.44	.41	.38	.44	.41	.38	.40	.38
		1.5	.47	.44	.41	.46	.43	.41	.43	.41
		2.0	.51	.48	.45	.50	.47	.45	.47	.45
		2.5	.54	.51	.49	.53	.51	.49	.51	.49
		3.0	.56	.54	.51	.55	.53	.51	.53	.51
		4.0	.58	.56	.54	.57	.55	.54	.55	.53
		5.0	.60	.58	.56	.58	.57	.55	.56	.55
5	Deep Bowl, Bowl-Enameled Lamp; 90° to 100°—6%; 0° to 90°—50%	0.6	.29	.26	.23	.29	.26	.23	.25	.23
		0.8	.35	.33	.31	.35	.32	.30	.32	.30
		1.0	.38	.36	.34	.38	.36	.34	.35	.34
		1.25	.41	.38	.37	.41	.39	.37	.38	.37
		1.5	.44	.41	.39	.43	.41	.39	.40	.39
		2.0	.47	.45	.43	.46	.44	.43	.43	.43
		2.5	.50	.48	.46	.49	.47	.46	.46	.46
		3.0	.51	.49	.47	.50	.48	.47	.47	.47
		4.0	.53	.51	.50	.52	.50	.49	.49	.49
		5.0	.54	.52	.51	.53	.51	.50	.50	.49
6	Flat Cone, Shielding Bowl, Clear Lamp; 90° to 100°—1%; 0° to 90°—54%	0.6	.27	.23	.21	.26	.23	.21	.23	.21
		0.8	.32	.30	.28	.32	.29	.27	.29	.27
		1.0	.35	.33	.31	.35	.33	.31	.32	.31
		1.25	.38	.36	.34	.38	.36	.34	.35	.34
		1.5	.40	.38	.36	.39	.37	.36	.37	.36
		2.0	.43	.41	.39	.42	.41	.39	.40	.39
		2.5	.46	.44	.42	.45	.43	.42	.43	.42
		3.0	.47	.45	.43	.46	.44	.43	.44	.43
		4.0	.49	.47	.46	.48	.46	.45	.46	.45
		5.0	.50	.48	.47	.49	.47	.46	.47	.46
7	Flat Cone, Clear Lamp; 90° to 100°—16%; 0° to 90°—74%	0.6	.26	.20	.16	.26	.19	.16	.19	.16
		0.8	.32	.26	.22	.32	.26	.22	.26	.22
		1.0	.36	.30	.26	.36	.30	.26	.30	.26
		1.25	.41	.35	.30	.39	.34	.30	.33	.30
		1.5	.44	.38	.33	.42	.37	.33	.36	.33
		2.0	.50	.44	.38	.48	.43	.38	.42	.38
		2.5	.54	.48	.42	.52	.47	.42	.46	.42
		3.0	.57	.51	.46	.55	.50	.45	.49	.45
		4.0	.62	.56	.51	.60	.54	.50	.53	.50
		5.0	.65	.60	.54	.62	.56	.53	.55	.53

DIRECT LIGHTING ENCLOSING AND SEMI-ENCLOSING UNITS

	Reflector Type	Room Index	Very Light (75%) Ceiling / Fairly Dark (30%) Walls	Very Light (75%) Ceiling / Fairly Dark (30%) Walls	Very Light (75%) Ceiling / Very Dark (10%) Walls	Fairly Light (50%) Ceiling / Fairly Dark (30%) Walls	Fairly Light (50%) Ceiling / Very Dark (10%) Walls	Fairly Dark (30%) Ceiling / Fairly Dark (30%) Walls	Fairly Dark (30%) Ceiling / Very Dark (10%) Walls
			Coefficients of Utilization						
15	Diffusing Globe, Light Opal; 90° to 100°—35%; 0° to 90°—40%	0.6	.18	.13	.10	.16	.12	.10	.10	.09
		0.8	.22	.17	.14	.20	.16	.13	.14	.12
		1.0	.26	.21	.18	.23	.19	.16	.17	.14
		1.25	.29	.24	.21	.26	.22	.19	.19	.16
		1.5	.32	.27	.23	.29	.24	.21	.22	.19
		2.0	.37	.32	.28	.32	.28	.25	.25	.22
		2.5	.40	.35	.31	.35	.31	.28	.28	.25
		3.0	.43	.38	.34	.38	.33	.30	.30	.27
		4.0	.47	.42	.38	.41	.37	.34	.33	.31
		5.0	.49	.45	.41	.43	.39	.36	.34	.33
16	One-Piece Opal, Flattened Reflecting; 90° to 100°—35%; 0° to 90°—45%	0.6	.22	.17	.14	.20	.16	.13	.14	.12
		0.8	.27	.22	.19	.25	.21	.18	.19	.17
		1.0	.31	.26	.23	.28	.24	.21	.22	.19
		1.25	.35	.30	.26	.31	.27	.24	.25	.22
		1.5	.38	.33	.29	.34	.30	.27	.27	.24
		2.0	.42	.38	.33	.38	.34	.31	.31	.28
		2.5	.46	.41	.37	.41	.37	.34	.34	.31
		3.0	.49	.45	.40	.43	.39	.36	.36	.33
		4.0	.53	.48	.44	.47	.43	.40	.38	.36
		5.0	.55	.51	.47	.49	.45	.42	.40	.38
17	Diffusing Globe, Large Metal Reflector; 90° to 100°—6%; 0° to 90°—58%	0.6	.22	.17	.14	.22	.17	.14	.17	.14
		0.8	.28	.23	.20	.27	.23	.19	.23	.19
		1.0	.31	.26	.23	.31	.26	.23	.26	.23
		1.25	.34	.30	.26	.33	.29	.26	.29	.26
		1.5	.36	.32	.29	.36	.32	.28	.31	.28
		2.0	.41	.37	.33	.40	.36	.33	.35	.32
		2.5	.44	.41	.37	.43	.40	.37	.39	.36
		3.0	.47	.43	.39	.45	.42	.39	.41	.39
		4.0	.50	.47	.43	.48	.45	.43	.44	.42
		5.0	.52	.49	.45	.50	.47	.44	.46	.44
18	Semi-Enclosing, Metal Reflector; 90° to 100°—39%; 0° to 90°—56%	0.6	.22	.17	.13	.21	.16	.13	.15	.13
		0.8	.28	.22	.19	.26	.21	.18	.21	.18
		1.0	.32	.26	.23	.30	.25	.22	.24	.21
		1.25	.35	.30	.26	.32	.28	.25	.27	.24
		1.5	.38	.33	.28	.36	.31	.27	.30	.26
		2.0	.43	.38	.33	.40	.36	.32	.34	.30
		2.5	.46	.41	.37	.44	.39	.36	.37	.34
		3.0	.49	.44	.40	.46	.42	.38	.40	.37
		4.0	.54	.49	.44	.50	.45	.42	.43	.40
		5.0	.56	.51	.47	.52	.47	.45	.44	.43
19	Semi-Enclosing, Compo Reflector; 90° to 100°—13%; 0° to 90°—40%	0.6	.24	.18	.14	.23	.18	.14	.17	.14
		0.8	.30	.24	.21	.29	.24	.20	.23	.20
		1.0	.33	.28	.25	.32	.28	.24	.27	.24
		1.25	.37	.32	.28	.35	.31	.27	.30	.27
		1.5	.39	.35	.31	.38	.34	.30	.32	.29
		2.0	.44	.40	.35	.42	.38	.34	.37	.34
		2.5	.48	.44	.39	.46	.42	.38	.41	.38
		3.0	.50	.46	.42	.48	.44	.41	.43	.40
		4.0	.55	.51	.47	.53	.49	.45	.46	.44
		5.0	.57	.53	.49	.54	.50	.47	.48	.46
20	Two-Piece Glass, Opal Reflector and Enameled Bowl; 90° to 100°—12%; 0° to 90°—33%	0.6	.22	.17	.14	.21	.17	.14	.16	.14
		0.8	.27	.23	.20	.26	.22	.19	.22	.19
		1.0	.30	.26	.23	.29	.26	.23	.25	.22
		1.25	.33	.29	.26	.32	.28	.26	.29	.25
		1.5	.36	.32	.29	.35	.31	.28	.31	.27
		2.0	.41	.37	.33	.39	.35	.32	.34	.31
		2.5	.44	.40	.36	.42	.38	.35	.37	.35
		3.0	.46	.42	.38	.43	.40	.37	.39	.37
		4.0	.49	.45	.42	.47	.43	.41	.42	.40
		5.0	.51	.48	.44	.48	.45	.43	.43	.41
21	One-Piece Glass, Enameled Reflector and Bowl; 90° to 100°—22%; 0° to 90°—39%	0.6	.22	.17	.14	.21	.16	.14	.15	.14
		0.8	.27	.23	.20	.26	.22	.19	.20	.18
		1.0	.30	.26	.23	.29	.25	.22	.23	.21
		1.25	.34	.30	.26	.32	.28	.25	.26	.24
		1.5	.37	.33	.29	.34	.30	.27	.28	.26
		2.0	.41	.37	.33	.38	.34	.31	.32	.30
		2.5	.44	.40	.36	.41	.38	.35	.35	.33
		3.0	.47	.43	.39	.43	.40	.37	.37	.35
		4.0	.51	.47	.43	.47	.44	.41	.41	.39
		5.0	.53	.49	.45	.48	.45	.42	.42	.40

DIRECT LIGHTING OPEN GLASS REFLECTORS

	Reflector Type	Room Index	Coefficients of Utilization							
8	Light Density Opal, Clear Lamp; 90° to 100°—33%; 0° to 90°—54%	0.6	.26	.21	.17	.24	.19	.16	.18	.15
		0.8	.32	.27	.23	.30	.25	.22	.24	.21
		1.0	.36	.31	.27	.34	.29	.26	.27	.24
		1.25	.40	.35	.31	.37	.32	.29	.30	.27
		1.5	.44	.38	.34	.40	.35	.32	.32	.30
		2.0	.49	.44	.39	.45	.40	.37	.37	.34
		2.5	.53	.48	.44	.49	.44	.41	.40	.38
		3.0	.56	.51	.47	.51	.46	.43	.42	.40
		4.0	.60	.55	.51	.55	.50	.47	.46	.44
		5.0	.62	.58	.54	.57	.53	.50	.48	.46
9	Light Density Opal, Bowl-Enameled Lamp; 90° to 100°—35%; 0° to 90°—65%	0.6	.22	.17	.14	.20	.16	.13	.14	.12
		0.8	.27	.22	.19	.25	.21	.18	.19	.16
		1.0	.31	.26	.23	.28	.24	.21	.22	.19
		1.25	.35	.30	.26	.31	.27	.24	.24	.22
		1.5	.38	.33	.29	.34	.30	.26	.27	.24
		2.0	.43	.38	.34	.38	.34	.31	.30	.28
		2.5	.47	.42	.38	.42	.38	.34	.34	.31
		3.0	.49	.44	.40	.44	.40	.37	.36	.33
		4.0	.53	.49	.45	.48	.44	.41	.39	.37
		5.0	.56	.52	.48	.50	.46	.43	.40	.39
10	Bench Opal, Clear Lamp; 90° to 100°—15%; 0° to 90°—67%	0.6	.32	.27	.23	.31	.26	.22	.25	.22
		0.8	.40	.35	.31	.38	.34	.31	.33	.30
		1.0	.44	.39	.36	.42	.38	.35	.37	.35
		1.25	.47	.43	.40	.46	.42	.39	.40	.38
		1.5	.51	.47	.43	.49	.45	.42	.43	.41
		2.0	.56	.52	.48	.54	.50	.47	.48	.46
		2.5	.60	.56	.53	.57	.54	.52	.52	.50
		3.0	.63	.59	.55	.60	.56	.54	.54	.52
		4.0	.66	.63	.60	.63	.60	.58	.57	.55
		5.0	.67	.65	.62	.65	.61	.59	.59	.57
11	Bench Opal, Bowl-Enameled Lamp; 90° to 100°—16%; 0° to 90°—66%	0.6	.29	.24	.20	.28	.23	.20	.22	.20
		0.8	.35	.31	.28	.34	.30	.27	.29	.27
		1.0	.39	.35	.32	.38	.34	.32	.33	.31
		1.25	.43	.39	.36	.41	.38	.35	.36	.34
		1.5	.46	.42	.38	.44	.40	.37	.38	.36
		2.0	.51	.47	.44	.48	.45	.42	.43	.41
		2.5	.55	.51	.48	.52	.49	.46	.47	.45
		3.0	.57	.54	.50	.54	.51	.48	.48	.46
		4.0	.60	.57	.54	.57	.54	.52	.51	.50
		5.0	.62	.59	.56	.58	.56	.54	.53	.52
12	Mirrored Glass, Clear Lamp; 90° to 100°—6%; 0° to 90°—66%	0.6	.32	.27	.24	.31	.27	.24	.27	.24
		0.8	.39	.35	.32	.39	.35	.32	.35	.32
		1.0	.43	.39	.37	.42	.39	.37	.39	.37
		1.25	.46	.43	.40	.46	.43	.40	.42	.40
		1.5	.49	.46	.43	.48	.45	.43	.45	.43
		2.0	.53	.50	.48	.52	.50	.48	.49	.48
		2.5	.57	.54	.52	.56	.54	.52	.53	.52
		3.0	.58	.56	.54	.57	.55	.54	.54	.53
		4.0	.61	.59	.57	.60	.58	.56	.57	.56
		5.0	.63	.61	.58	.61	.59	.58	.58	.57
13	Mirrored Glass, Bowl-Enameled Lamp; 90° to 100°—6%; 0° to 90°—75%	0.6	.26	.22	.19	.25	.22	.19	.21	.19
		0.8	.32	.29	.26	.31	.28	.26	.28	.26
		1.0	.35	.32	.30	.34	.32	.30	.31	.30
		1.25	.38	.35	.33	.37	.35	.33	.34	.33
		1.5	.40	.37	.35	.39	.37	.35	.36	.35
		2.0	.43	.41	.39	.42	.40	.39	.40	.39
		2.5	.46	.44	.42	.45	.43	.42	.43	.42
		3.0	.47	.46	.44	.46	.45	.44	.44	.43
		4.0	.49	.48	.46	.48	.47	.46	.46	.45
		5.0	.50	.49	.47	.49	.48	.47	.47	.46
14	Prismatic Directional, Clear Lamp; 90° to 100°—18%; 0° to 90°—73%	0.6	.33	.26	.21	.31	.25	.21	.24	.20
		0.8	.41	.35	.30	.39	.33	.29	.32	.29
		1.0	.45	.40	.35	.43	.39	.34	.37	.33
		1.25	.50	.44	.39	.47	.42	.38	.40	.37
		1.5	.52	.48	.43	.50	.45	.42	.43	.40
		2.0	.58	.54	.49	.56	.51	.47	.49	.46
		2.5	.63	.59	.54	.60	.56	.53	.54	.51
		3.0	.66	.62	.58	.63	.59	.56	.56	.54
		4.0	.71	.67	.63	.67	.63	.61	.60	.58
		5.0	.73	.69	.66	.69	.65	.63	.62	.60

SEMI-INDIRECT AND INDIRECT LIGHTING UNITS

	Reflector Type	Room Index	Coefficients of Utilization							
22	Light Opal; 90° to 100°—40°; 0° to 90°—25°	0.6	.18	.14	.11	.15	.12	.09	.09	.07
		0.8	.22	.18	.15	.19	.15	.12	.12	.10
		1.0	.26	.22	.18	.22	.18	.15	.14	.12
		1.25	.30	.25	.22	.25	.21	.18	.16	.14
		1.5	.33	.28	.24	.27	.23	.20	.18	.16
		2.0	.38	.33	.29	.31	.27	.24	.21	.19
		2.5	.41	.36	.32	.34	.30	.27	.24	.22
		3.0	.44	.39	.35	.36	.32	.29	.25	.23
		4.0	.49	.44	.40	.40	.36	.33	.28	.26
		5.0	.51	.46	.42	.42	.38	.35	.29	.28
23	Bowl Opal for Light Opal and Bowl-Enameled Lamp; 90° to 100°—70°; 0° to 90°—10°	0.6	.16	.13	.11	.12	.10	.08	.07	.06
		0.8	.20	.17	.15	.16	.13	.11	.09	.08
		1.0	.23	.20	.17	.18	.15	.13	.10	.09
		1.25	.27	.23	.20	.21	.18	.16	.12	.11
		1.5	.29	.26	.22	.23	.19	.17	.13	.12
		2.0	.33	.29	.26	.26	.22	.20	.15	.14
		2.5	.36	.32	.29	.28	.25	.23	.17	.16
		3.0	.39	.35	.32	.29	.27	.25	.18	.17
		4.0	.43	.39	.36	.32	.30	.28	.20	.19
		5.0	.45	.41	.38	.34	.32	.30	.22	.20
24	Enameled Metal Reflector, Opal Glass Bowl; 90° to 100°—41°; 0° to 90°—14°	0.6	.18	.15	.13	.14	.12	.11	.09	.08
		0.8	.22	.19	.17	.18	.16	.14	.12	.11
		1.0	.25	.22	.20	.20	.18	.16	.14	.13
		1.25	.29	.25	.22	.23	.21	.19	.15	.15
		1.5	.31	.28	.25	.25	.22	.20	.17	.16
		2.0	.34	.31	.29	.28	.25	.23	.19	.18
		2.5	.37	.34	.32	.30	.28	.26	.21	.20
		3.0	.39	.36	.34	.31	.29	.27	.21	.20
		4.0	.43	.40	.38	.34	.32	.30	.23	.22
		5.0	.45	.42	.40	.36	.34	.32	.25	.23
25	Bowl-enameled Lamp; 90° to 100°—40%; 0° to 90°—6°	0.6	.16	.13	.11	.12	.10	.08	.07	.06
		0.8	.19	.16	.14	.15	.13	.11	.08	.08
		1.0	.22	.19	.17	.17	.15	.13	.10	.09
		1.25	.25	.22	.19	.20	.17	.15	.11	.10
		1.5	.27	.24	.21	.21	.18	.16	.12	.11
		2.0	.31	.28	.25	.24	.21	.19	.14	.13
		2.5	.34	.31	.28	.25	.23	.22	.15	.15
		3.0	.36	.33	.31	.27	.25	.23	.16	.15
		4.0	.40	.37	.34	.29	.28	.26	.18	.17
		5.0	.41	.38	.37	.31	.29	.28	.19	.18
26	Clear Top Enclosed Enameled Glass; 90° to 100°—54°; 0° to 90°—21%	0.6	.16	.12	.10	.13	.10	.08	.07	.06
		0.8	.20	.16	.13	.17	.13	.11	.10	.09
		1.0	.23	.19	.16	.19	.15	.13	.12	.10
		1.25	.26	.22	.19	.21	.18	.15	.14	.12
		1.5	.29	.25	.21	.24	.20	.17	.15	.13
		2.0	.32	.28	.25	.26	.23	.20	.18	.16
		2.5	.36	.31	.28	.29	.26	.23	.20	.18
		3.0	.38	.34	.31	.31	.28	.25	.22	.20
		4.0	.42	.38	.35	.34	.31	.29	.24	.22
		5.0	.44	.40	.37	.36	.33	.31	.25	.24
27	Mirrored Indirect; 90° to 100°—48°; 0° to 90°—6°	0.6	.15	.12	.10	.11	.09	.07	.08	.04
		0.8	.18	.15	.13	.13	.11	.09	.07	.06
		1.0	.22	.19	.16	.15	.13	.11	.08	.07
		1.25	.25	.22	.19	.18	.15	.13	.09	.08
		1.5	.27	.24	.21	.20	.17	.15	.10	.09
		2.0	.30	.27	.25	.22	.19	.17	.11	.10
		2.5	.34	.31	.28	.24	.22	.20	.13	.12
		3.0	.36	.33	.30	.26	.24	.22	.14	.13
		4.0	.40	.37	.34	.28	.26	.24	.15	.14
		5.0	.42	.39	.37	.30	.28	.26	.17	.15
28	Enameled Metal Indirect; 90° to 100°—30%; 0° to 90°—6%	0.6	.14	.11	.10	.10	.08	.07	.04	.04
		0.8	.17	.14	.13	.13	.10	.09	.06	.05
		1.0	.20	.17	.15	.14	.12	.10	.07	.06
		1.25	.23	.20	.17	.17	.14	.13	.08	.07
		1.5	.25	.22	.19	.18	.15	.14	.09	.08
		2.0	.28	.25	.23	.21	.18	.16	.10	.10
		2.5	.31	.28	.26	.22	.20	.18	.12	.11
		3.0	.33	.30	.28	.24	.22	.20	.13	.12
		4.0	.37	.34	.32	.26	.24	.22	.14	.13
		5.0	.39	.36	.34	.28	.26	.24	.15	.14

FIG. 2—UTILIZATION FACTORS MUST BE CONSIDERED IF THE INSTALLATION IS TO GIVE SATISFACTORY SERVICE

tenance; (6) vertical illumination. On the other hand, where lamps are to be hung above a crane in a foundry the order of importance would be: (1) Efficiency based upon illumination on horizontal; (2) vertical illumination; (3) maintenance; (4) shadows; (5) direct glare; (6) reflected glare.

In Fig. 1 the highest rating given is *A*+, denoting excellence, while *D*, the lowest, indicates that units so rated in that particular will very likely prove unsatisfactory in an installation where this factor is important. The ratings *B* and *C*, while indicating a result not equal to *A*, are decidedly superior to rating *D*. In other words, a rating *B*, *C*+ or *C* in certain respects does not disqualify a unit provided that in the essential requirements of a given location the unit is rated *A* or *B*+.

A+, *A*, *A*— } Excellent *B*+, *B*, *B*— } Good *C*+, *C*, *C*— } Fair *D*—Very Bad

Determining Outlets, Mounting Height and Number of Units

Having solved the first two steps of the illumination problem, the third point in the design—that of determining the details of arrangement—comes up. One way to handle this is to make a diagram of the floor. If the units are of semi-indirect or totally indirect type, measure the ceiling height of the room and refer to Table III for the permissible spacing of units and preferred suspension distance of lighting units corresponding to this ceiling height.

TABLE III—SPACING AND MOUNTING HEIGHT FOR LIGHTING UNITS

Mounting Height of Unit*	Permissible Distance Between Outlets	Permissible Distance Between Outlets and Side Walls: In Usual Locations Where Aisles and Storage Are Next to Wall	Permissible Distance Between Outlets and Side Walls: In Offices or Where Work Benches Are Not Next to Wall	Suspension Distance, Indirect Units, Ceiling to Top of Reflector†
4	6	3	2	1
5	7½	3½	2½	1½
6	9	4½	3	1½
7	10½	5	3½	1½
8	12	6	4	2
9	13½	6½	4½	2½
10	15	7½	5	2½
11	16½	8	5½	2½
12	18	9	6	3
13	19½	9½	6½	3½
14	21	10½	7	3½
15	22½	11	7½	3½
16	24	12	8	4
18	27	13½	9	4½
20	30	15	10	5
22	33	16½	11	5½
24	36	18	12	6
27	40½	20	13½	6½
30	45	22½	15	7½
35	52½	26	17½	8½
40	60	30	20	10

* Note that the permissible distance between outlets depends upon the height of the light source above the work, not above the floor. In offices, the work plane corresponds to the desk tops, usually 2½ ft. above the floor; in factories, the work plane will often be 3½ or 4 ft. above the floor. Note that in the case of semi- and totally-indirect lighting units, the figures in this column are the height of the ceiling above the work.

† Suspension distances are based on best distribution of light and efficiency of utilization for standard units. In some installations other considerations may require a different suspension distance.

If the units are direct-lighting type, determine the mounting height and refer to Table III for the permissible spacing corresponding to this mounting height. If the units are mounted as close to the ceiling as possible (a minimum allowance of one foot is usually necessary to provide for the drop of the reflector from the ceiling), a wider spacing is permissible and fewer units are therefore necessary for an even distribution of light. Considerations of shadows, the appearance and arrangement of work may make a lesser mounting height desirable even though a closer spacing of outlets would be needed to keep the same uniformity of illumination. Ordinarily lamps should not be mounted less than 10 ft. (3 m.) above the floor unless a low ceiling makes it necessary.

Outlets Are Located Symmetrically If Possible

Having determined the permissible spacing, proceed to locate the outlets on the diagram of the floor, placing the units as nearly symmetrically as possible without appreciably exceeding the permissible spacing for a uniform illumination. At a greater height, a spacing closer than that in Table III results in greater freedom from shadows, but increases the number of units required and makes the installation cost more. If a spacing somewhat closer than the permissible value is adopted, as is often the case, it is allowable, though not necessary, to refer back to Table III and select a lower mounting height corresponding to the new spacing. As shown in Table III, the distance between the outside row of outlets and the wall should not exceed one-half the spacing distance, and for office spaces, or where work is carried on at benches or machines near the wall, this distance should be approximately one-third the spacing distance.

The average area per outlet is found from the floor area of the room and the number of outlets located on the diagram as follows: Area in square feet per outlet equals the total floor area in square feet divided by the number of outlets in room.

The necessary lumen output for the lamp in each outlet of the system may be found directly from the following formula:

$$\text{Lamp lumens per outlet} = \frac{\text{foot-candles} \times \text{depreciation factor}}{\text{coefficient of utilization}} \times \text{area in sq.ft. per outlet}$$

In this formula

Foot-candles = illumination decided upon

Depreciation factor = safety factor or allowance for depreciation due to aging of lamps, dirt, dust and deterioration of reflecting value of walls. Use 1.30 for fairly clean locations. Use 1.50 for dirty locations or where cleaning is infrequent.

Area = area in square feet per outlet.

Coefficient of utilization = proportion of the generated light from the lamps which reaches the plane of work. The coefficient of utilization for the installation is determined as outlined below:

Determining Coefficient of Utilization

Fig. 2 shows that the coefficient of utilization varies according to the type of fixture, the color of the walls and ceiling and the proportions of the room or "room index." From Table II find the room index corresponding most nearly to the dimensions of the installation; then the coefficient of utilization for the installation of the type of lighting unit selected will be found from Fig. 2 in the proper column of wall and ceiling color opposite the correct room index.

Solving the formula above, after substituting the proper values for foot-candles, depreciation factor, coefficient of utilization and the area per outlet, gives the lamp lumens necessary per outlet.

To find the wattage of lamp required, refer to Table IV, which lists the lumen output rating for lamps. Locate in this table the size of lamp of the desired type which most nearly meets the requirement of lumen

output. When the lamp lumens required fall nearly midway between the two sizes, choose the larger rather than the smaller, unless it is certain that the less illumination from the smaller will suffice.

SOLVING A TYPICAL PROBLEM

In order to give a more definite and practical idea of how this method of illuminating design is used, the layout for a typical factory room as shown in the headpiece of this article may be followed out. The floor plan of the factory space to be lighted is 60 ft. x 120 ft. (18 m. x 36 m.), with a height from floor to room trusses of 12 ft. (4.2 m.). The roof is of sawtooth construction and the walls and upper structure are painted a medium color. A considerable amount of dark material is kept stacked along the walls of the room which will have an effect in the lighting design. The work carried on is the assembly of sewing-machine heads.

TABLE IV—LUMEN OUTPUT OF TUNGSTEN-FILAMENT LAMPS
(Subject to change without notice)

Size of Lamp in Watts	110-125-Volt Standard Lighting Service			220-250-Volt	
	Type C	Type B	Daylight	Type C	Type B
10	....	75	.....	.....	...
15	....	125	.....	.....	...
25	....	226	.....	.....	191
40	....	372	.....	.....	...
50	450*	480	.....	.....	442
60	....	575	.....	.....	...
75	865	...	600	.....	...
100	1,260	...	875	995	945
150	2,040	...	1,400	.....	...
200	3,100	...	2,000	2,520	...
300	4,840	...	3,360	4,100	...
500	8,750	...	5,600	7,850	...
750	13,900	...	.....	.....	...
1,000	19,300	...	.....	17,500	...

* White.

The four steps in the design are worked out as follows:

1. *Foot-Candle Illumination.*—From Table I, 8 foot-candles is recommended for assembly, medium grade.

2. *Type of Lighting Unit.*—Consulting the guide to the selection of reflecting equipment of Fig. 1, unit No. 2, the RLM dome with bowl-enameled lamp is selected, based on efficiency and favorable showing from the standpoint of glare, reflected glare, shadows and maintenance.

3. *Location of Outlets, Mounting Height and Number of Units.*—The height of the benches, and therefore the plane of work, is 3½ ft. above the floor. The maximum mounting height of the lamps above the floor is 11 ft. (12 ft. height from floor to truss less 1 ft. allowed for reflector drops). Hence maximum mounting height of units above plane of work is 11 ft. (3.3 m.) less 3½ ft. (1.1 m.), or 7½ ft. (2.3 m.)

From Table III of spacing-mounting height, a 7½-ft. (2.3-m.) mounting height above plane for direct-lighting units is found to indicate a permissible spacing of approximately 11 ft., and since the section of the room near the walls consists of aisles and storage, 5½ ft. (1.7 m.) may be allowed for the distance between the last row of outlets and the side walls.

The floor plan of the room shows that a 10-ft. (3-m.) spacing each way, with outside units 5 ft. (1.6 m.) from walls, would make a symmetrical layout in the 20-ft. x 30-ft. (6-m. x 9.1-m.) bays, and this plan is therefore adopted. Outlet locations for the entire space are marked on the plan, and seventy-two are found to be required. The area in square feet per outlet equals the total floor area in square feet divided by the number of outlets in room (7,200 ÷ 72 = 100).

4. *Lamp Size.*—Lamp lumens per outlet =

$$\frac{\text{foot-candles} \times \text{depreciation factor}}{\text{coefficient of utilization}} \times \text{area in sq.ft. per outlet}$$

Area in square feet per outlet = 100; foot-candles = 8; depreciation factor = 1.30.

To Find Coefficient Utilization.—From the room index (Table II), in a room 60 ft. x 120 ft., where the mounting height of direct-lighting units above plane of work is 7 ft., the room index is 5.0, or in the same room where the mounting height is 8 ft. the room index is 4.0. Either value might be used for the room index with equal accuracy as to the result, but 4.0 is more conservative.

Referring to Fig. 2, coefficients of utilization, for RLM dome bowl-enameled lamps in a location with a room index of 4.0 and where the ceiling and walls are fairly dark, the coefficient of utilization is found to be 0.57. Hence lamp lumens required per outlet = [(8 × 1.30) × 100] ÷ 0.57 = 1,824.

From Table IV a 150-watt Mazda C lamp giving 2,040 lumens is found most nearly to meet the requirements. The actual service illumination using this lamp will, of course, be slightly greater than originally designed for, or (2,040 ÷ 1,824) × 8 = 8.9 foot-candles.

Building Transmission Lines Vs. Paying Freight on Coal

Determining Factors Are Fixed Charges of Line, Freight Charges on Fuel and Relative Thermal Efficiencies and Construction Costs of the Two Plants

BY H. L. WALLAU
Electrical Engineer Cleveland Electric Illuminating Company

THE difficulties of transportation, coupled with rising freight rates, bring forcibly to mind the advisability of generating power at the mine and transmitting it to the market, thus eliminating the haulage of a considerable tonnage of fuel and consequently reducing the congestion of freight traffic. The engineer is therefore more and more likely to be called upon to answer the question "Can we or can we not afford to generate at the mine and transmit to the market?"

There are three questions which must be answered to solve the problem: (1) Will the production efficiencies of plants at the mine and at the market be equal? This includes generating efficiency as well as transmission efficiency. (2) Can the plants be built for equal costs per kilowatt of rating? (3) Will the fixed charges on the line be less, equal to or greater than the freight charges on the fuel? The last question is usually the most important. Often it may be settled by comparing the estimated cost of constructing the line with cost of transmission justifiable at the existing freight rate.

The following method of determining the justifiable cost of transmission may be found convenient: First, set up the probable fuel requirements in pounds per kilowatt-hour for the type of plant likely to be built for annual load factors of 50, 75 and 100 per cent (line *c* in the table on page 423). Next, calculate the kilowatt-hours per kilowatt of peak load for each load factor and the corresponding annual fuel requirements (*d*). Then figure the freight charges on the coal required to generate one kilowatt-year. Freight

charges are shown in the accompanying table for an assumed plant and with freight rates varying from $1 to $2 by 25-cent increments. In order to find at what rate the freight charges may be capitalized it is necessary to determine the fixed charges on the proposed transmission-line investment which will equal the freight charges. The figures assigned must, of course, be based on the company's own experience. Assume the following: Cost of money, 9 per cent; taxes, 2 per cent; maintenance, 6 per cent, and deferred upkeep, 3 per cent, giving total fixed charges of 20 per cent. Letting this 20 per cent of the cost of the line equal the freight charges, the total cost of the line may be figured. This cost of transmission line per kilowatt of peak load for the various load factors and freight rates assumed is shown at the bottom of the table (*g*). The curves show graphically the results secured by these calculations.

Knowing the maximum amount which should be spent on lines the next step is to calculate the size of lines required and to make an estimate covering their cost. This should include the cost of step-up and step-down equipment, protective apparatus, spare circuits, etc. This figure divided by the safe capacity of the plant (one unit not operating) gives the cost per kilowatt of peak load. For purpose of illustration assume that this resulted in a cost of $30 per installed kilowatt. Draw a horizontal line through this point on the chart and it will intersect the cost curves plotted. If the freight rate for coal delivered to the market is $1.50 per ton it is obvious that in order to offset this freight rate the plant at the mine must be operated at an annual load factor of not less than 52 per cent, at which point the actual and justifiable cost lines intersect. If a better annual load factor can be maintained economies will accrue. If the freight rate were only 75 cents per ton it can be seen that even at an annual load factor of 100 per cent it would be cheaper to haul the fuel.

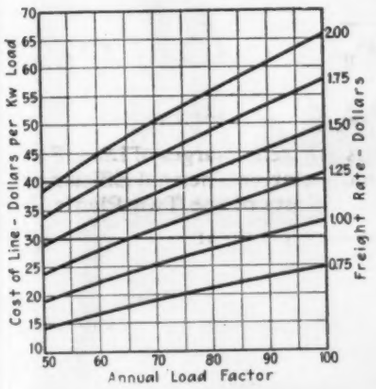


CHART TO BALANCE COST OF TRANSMISSION LINE FROM MINE AGAINST COST OF SHIPPING COAL

Reverting now to question 1, assume that because of natural facilities a plant at the market could be operated with a higher average vacuum and therefore a better thermal efficiency than a similar plant at the mine. For instance, assume a fuel economy of only 2 lb. (0.9 kg.) of coal per kilowatt-hour at 50 per cent load factor instead of 1.75 lb. (0.8 kg.). Then additional fuel per kilowatt-year to the amount of 1,095 lb. (496 kg.) would be required. If a coal cost of $6 delivered at the mine plant is assumed this extra fuel adds $3.29 to the cost of a kilowatt-year, and the freight charge of $5.75 (based on $1.50 per ton) should be reduced by that amount before capitalizing. The figures assumed would therefore decrease the allowable transmission line cost to $12.30 per kilowatt, and it would be impossible to justify a mine plant.

Similarly referring to question 2, if the cost of a plant at the mine is greater per kilowatt (transmission-line equipment excluded), then this additional cost per kilowatt should be added to the cost of the transmission line as computed before plotting on the chart. For instance, if this cost at the mine were found to be $10 per kilowatt in excess it would be equivalent to a transmission line cost of $40 instead of $30. In this case an annual load factor of 75 per cent would have to be maintained at the mine plant to break even.

In the above discussion annual transmission losses have been neglected. If the answer to question 3 shows a reasonable leeway, calculations should then be made for various percentage losses resulting from transmission at different load factors.

The added fuel required to supply the losses may be treated from the point of view of kilowatt-hours delivered as equivalent to a decreased thermal efficiency at the mine plant; that is, an increase in pounds of coal required per kilowatt-hour, and calculations made as outlined under question 1, where plant conditions, instead of line losses, are assumed as being responsible for decreased fuel economy.

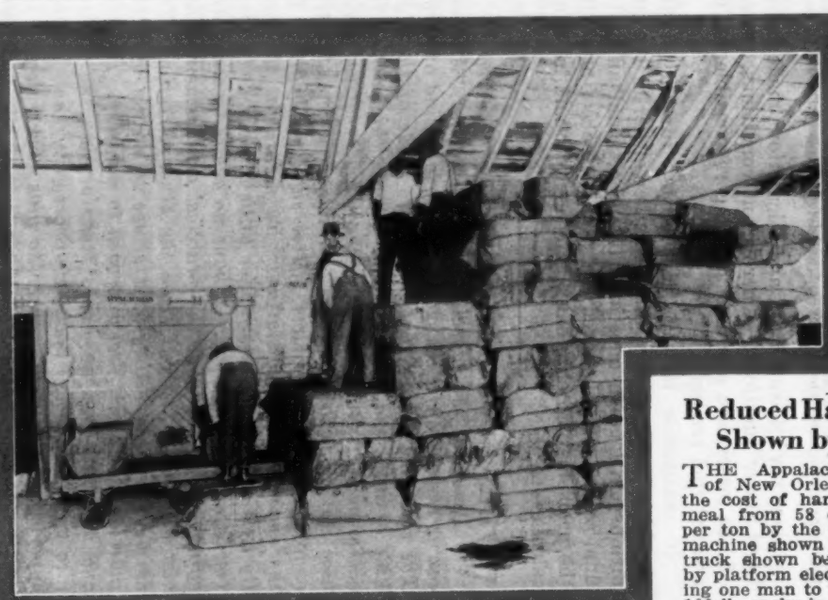
If reasonable leeway still exists, further studies should be made to determine whether either of the conditions outlined in questions 1 and 2 would affect the final result. It is believed that this method of attacking the problems will eliminate many lengthy and laborious calculations.

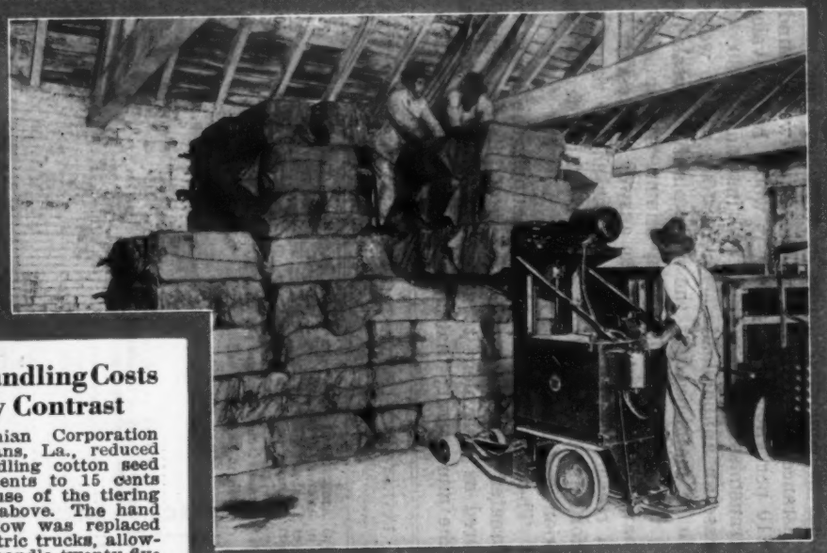
INVESTMENT IN TRANSMISSION LINE JUSTIFIED TO AVOID PAYING FREIGHT ON COAL

(a) Annual load factor, per cent	50	75	100
(b) Average daily load factor, per cent	67	84	100
(c) Coal per kilowatt-hour, lb	1.75	1.62	1.50
(d) Annual output per kilowatt of plant, kw.-hr	4,380	6,570	8,760
(e) Fuel per kilowatt-year, lb	7,665	10,645	13,140
(f) Annual freight charges per kilowatt-year:			
Freight Rate per Ton:			
$1.00	$3.83	$5.32	$6.57
1.25	4.79	6.65	8.21
1.50	5.75	7.98	9.86
1.75	6.71	9.31	11.50
2.00	7.67	10.64	13.14
(g) Justified cost of transmission line per peak kw.*:			
Freight Rate per Ton:			
$1.00	19.15	26.60	32.85
1.25	23.95	33.25	41.05
1.50	28.75	39.90	49.30
1.75	33.55	46.55	57.50
2.00	38.35	53.20	65.70

* Fixed charges assumed as 20 per cent, made up of: Cost of money, 9 per cent; taxes, 2 per cent; maintenance, 6 per cent, and deferred upkeep, 3 per cent.

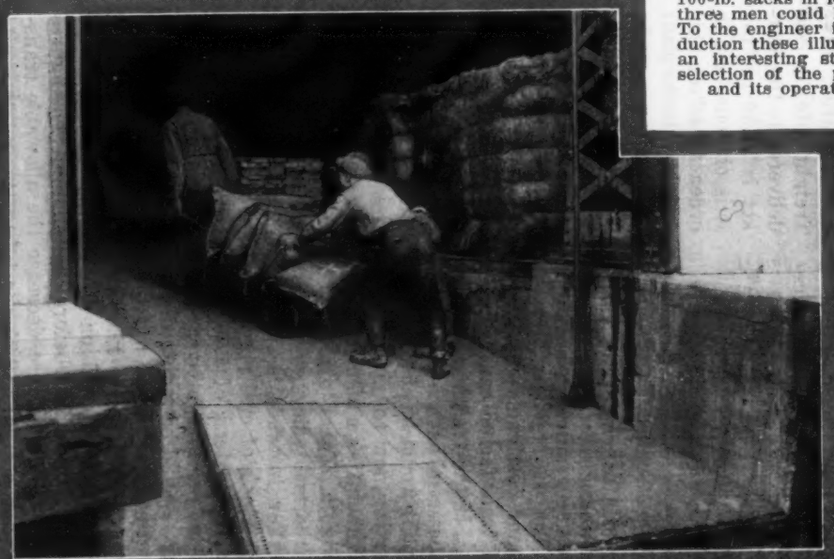
WHEN *notable achievements are referred to in America, the moralist often remarks: "Anybody can do the same if he is made of the right kind of stuff." The scientific fact is that people are made of the right kind of stuff, and human beings do have this passion for achievement. But how to release this creative power, how to give this passion an adequate constructive expression is the problem. How shall we begin? By the enactment of legislation? By reform at the top? By waiting for absolute justice to be arrived at between employer and employee? I have no desire to check any effort of the kind, but the practical achievements have historically worked out from the other direction. The most vital place to begin, it seems to me, is with the individual worker's first approach to industry. How far and how fast can we go in transforming the factory into a real school, in which opportunity shall succeed opportunity for each worker to give expression to his passion to accomplish something, where all shall learn things by doing things, and learn as many things and as important things as each individual is capable of accomplishing?*—CHARLES P. STEINMETZ.





Reduced Handling Costs Shown by Contrast

THE Appalachian Corporation of New Orleans, La., reduced the cost of handling cotton seed meal from 58 cents to 15 cents per ton by the use of the tiering machine shown above. The hand truck shown below was replaced by platform electric trucks, allowing one man to handle twenty-five 100-lb. sacks in less time than the three men could handle six sacks. To the engineer in charge of production these illustrations suggest an interesting study both in the selection of the proper apparatus and its operation afterward



Unit Basis for Wholesale and Retail Rates

Factors Influencing Make-Up of Rates—They May Be Based on Segregated Wholesale Rate Plan—Method of Apportioning Costs Indicated—Application to Definite Case

By N. A. KEMMISH
General Manager Public Service Company, York, Neb.

THE central-station industry has always been able to ascertain accurately the revenues received from the various classes of business and to tell fairly well what the combined total costs for all classes of business have been. When it tries, however, to obtain accurate costs of serving the various classes of business it is at a loss. It is equally at a loss when it attempts to apportion the total revenue required to each of the various classes of business, because costs are not known. The result has been the development of a wonderful system of guessing, and since all companies and all individuals cannot, and will not guess alike, all sorts of rates with no more resemblance between them than the individuals who made them have been developed. The greatest need at the moment is an accurate and uniform system of accounting that will make a proper segregation of costs between the different classes of business. Great progress has been made, but the goal is still a long way off. Greater progress can be made if a few fundamental principles are adopted and allowed to govern accounting systems and methods of procedure. The unit plan hereafter described is an attempt to develop a system capable of application by an isolated plant in a small town or by any combination of towns and transmission lines. There are two general schemes that can be employed, as follows: First—Any group can be divided into three main

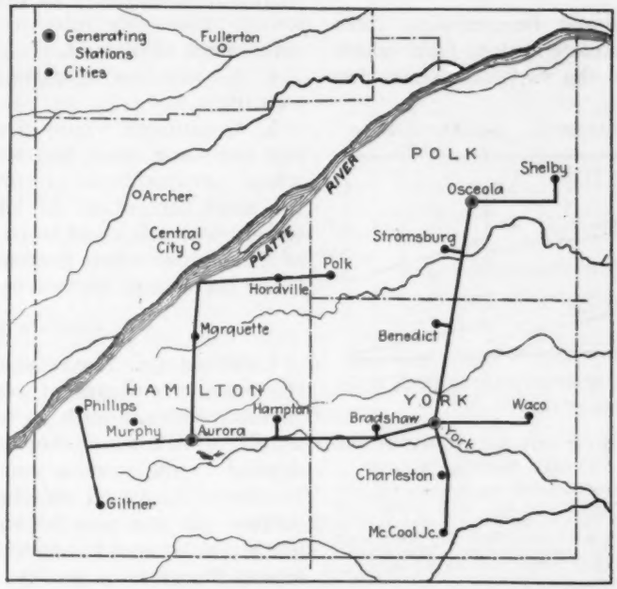


FIG. 1—THIS NEBRASKA SYSTEM USES A UNIT SYSTEM OF WHOLESALE AND RETAIL RATES

UNIT SYSTEM WHOLESALE AND RETAIL RATES AS DEVELOPED FOR A GROUP OF NEBRASKA OPERATING PROPERTIES

Total Kw.-Hr. Used per Month by Entire City	*Average Monthly Consumption, Kw.-Hr.		RETAIL RATES: †Lighting Rates (in Cents) Minimum Lighting Bill	Kw.-Hr. Consumption per Month: First 30	Next 30	Next 30	Over 90	†Power Rates (in Cents) Minimum Power Bill	Kw.-Hr. Consumption per Month: First 50	Next 100	Next 150	Next 200	Next 500	Next 500	Next 500	Next 1,000	Over 3,000	†Electric Range Rates (in Cents) Minimum Stove Bill	Kw.-Hr. Consumption per Month: First 100	Next 100	Next 100	Over 300	‡Average Wholesale Rate, Cents per Kw.-Hr.
0-2,000	R—Hordville	1,081	$1.50	22	19	18	15	$3.50	16	13	12	11½	11	10.8	10.7	10.6	10.5	$2.00	11	10	9	8½	$0.10
	R—McCool	1,463																					
	R—Waco	1,537																					
2,000–10,000	W—Benedict	2,810	1.50	20	17	14	13	3.50	15	12	11	10½	10	9.8	9.7	9.6	9.5	2.00	10	9	8	7½	.0815
	R—Marquette	2,915																					
	W—Bradshaw	3,818																					
	W—Polk	4,285																					
	W—Giltner(est.)	5,000																					
	W—Hampton	5,124																					
	R—Shelby	7,012																					
10,000–25,000	R—Stromberg	19,012	1.25	18	15	12	11	3.00	13	10	9	8½	8	7.8	7.7	7.6	7.5	1.50	8	7	6	5½	.0666
	R—Osceola	20,926																					
25,000–75,000	R—Aurora	61,571	1.25	16	13	10	9	3.00	11	8	7	6½	6	5.8	5.7	5.6	5.5	1.50	7	6	5½	5	.0566
75,000–150,000	R—York	106,295	1.25	14	11	8	7	3.00	10	7	6	5½	5	4.8	4.7	4.6	4.5	1.50	6	5½	5	4½	.0499

*Showing location in sliding scale of various towns. R = places in which company does retailing. W = places in which company does wholesaling, city doing retailing.

†10 per cent discount in lighting rates if paid in ten days from date of bill; power rates net; range rates net.

‡Wholesale Rates.—Minimum bill, $125 per month; first 2,000 kw.-hr., used per month, 10 cents; next 3,000 kw.-hr., 8 cents; next 5,000 kw.-hr., 7½ cents; next 10,000 kw.-hr., 6½ cents; next 15,000 kw.-hr., 5½ cents; next 25,000 kw.-hr. 5 cents; next 40,000 kw.-hr. 4½ cents; next 50,000 kw.-hr. 4¼ cents; over 150,000 kw.-hr., special rate. These rates are based on coal at $6 per ton of 2,000 lb. at the power plant, York, Neb. Should the average price of coal at this plant increase or decrease over the base of $6 per ton, then the above rates will be increased or decreased at the rate of $0.0020 (two-tenths cent) per kilowatt-hour for each 10-cent raise or decrease in the price of coal per ton. The above rates are based on an average load factor of 30 per cent. Should maximum demand be shown by occasional readings to be over 1/216 of the total number of kilowatt-hours used per month the electric company may at its discretion add such additional charges as are necessary to pay the overhead charges on the additional equipment necessary to supply.

divisions, namely, generation, transmission and distribution. Each would be a complete unit in itself, the transmission company buying its energy where it can at the lowest possible rate and selling it in turn to the various towns and wholesale consumers within reach of its lines. This is a decided departure from present practice and may be the best method to apply to the super-power systems as they develop. A disadvantage is that the smaller power plants would be squeezed out by the larger ones and that the whole system would suffer in case of transmission-line trouble because of lack of standby plants.

Second—The power plants and transmission lines might be considered as one complete system from which energy would be wholesaled to the various distribution

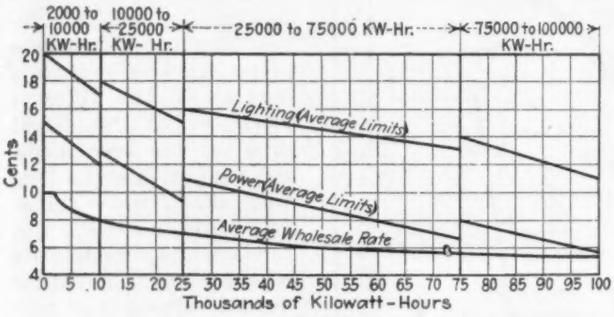


FIG. 2—UNIT RATE SCHEME IN WHICH THE RETAIL RATES ARE BUILT UP ON A SEGREGATED WHOLESALE RATE AS A BASE

The lighting and power rate curves indicate the maximum and minimum average rates. The average rates for each group are taken from the calculations for the curves in Fig. 3 and 4, and the curves indicate the relation of the average retail and wholesale rates for the assumed consumption in those figures. The groupings on which the wholesale and retail rates are based are expressed in kilowatt-hours consumption per month.

systems reached by its lines. These systems could be either single communities or secondary transmission systems, the main generation and transmission system in the latter case using extremely high voltage and covering a large area. This system would be concerned only in obtaining a rate for its service that would pay its operating and fixed charges and a fair profit on the business. The rate structure for the distribution service would be an independent problem and based on the service rendered by the distribution company.

In building the rate structure for the entire service the following are suggested as vital factors in a correct solution:

1. Total cost equals operating expenses plus overhead expense.

2. Gross revenue equals operating expenses plus overhead expense.

3. Operating expense must include all necessary and legitimate expenses falling under this head, including taxes, bad debts, etc.; also a reserve for renewals and contingencies and interest on current obligations.

4. Overhead expense includes a fair return for the use of capital and for enterprise in developing and carrying on the business, in which the following must be considered:

(a) The net income must never be less than the prevailing rate of interest on similar risk investments, in order that capital may be freely and continuously attracted to the enterprise.

(b) Efficiency and good service must be recognized by allowing a reasonable profit, in which the degree of efficiency is recognized by an increasing profit based on efficient management.

Gross earnings to provide total cost as defined in the foregoing should be apportioned among the various classes of service in accordance with their combined and individual "value of service" as follows:

1. When conditions are the same, rates to different groups of consumers or classes therein should be the same.

2. No rate should be below bare cost, and every rate should include a fair return on any investment added or used exclusively for that group or class of consumers.

3. Rates must be such that as many groups or individual consumers as possible may be served at the lowest practicable rates and yet a fair return on the investment be earned.

4. No rate can be above the "value of service" to the consumer.

5. Consumers whose circumstances are alike should pay the same rates, but it is not necessary that those whose circumstances are unlike should be asked to pay the same percentage on jointly used investment. Customers who are asked to pay a smaller return should be of a character whose presence on the system will help to lower the cost of service to consumers of all classes.

CLASSIFICATION OF RATES

1. Wholesale. The rates applied to communities where the energy is resold at retail or to consumers whose requirements are such as to class them with such communities. A common wholesale sliding-scale rate can be applied to the various communities or groups served. It should be based on the combined group value of service. It can also be employed to arrive at a proportion to be used in apportioning the revenues required among the users of service. These wholesale rates must provide revenue to pay all operating and overhead expenses apportioned to each class of service.

2. Retail. The distribution of energy may or may not be done by the wholesaler. In any event it may be considered as a separate problem. The rates for each group of consumers must be based on the same principles as the wholesale rates and return a revenue

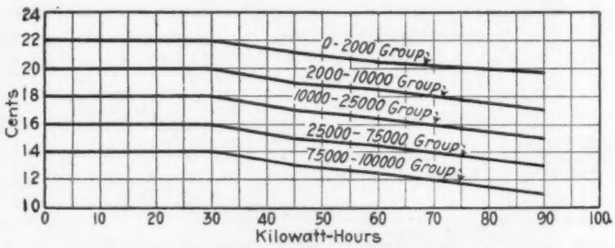


FIG. 3—AVERAGE LIGHTING RATES FOR VARIOUS OPERATING GROUPS

Minimum bills are omitted from consideration. See the table on page 425 for these minimums.

sufficient to pay all expenses apportioned to each class of consumer.

3. Types and forms of rates. These will vary with every system because of varying conditions and need not be discussed here. In any specific case the type best suited will usually suggest itself.

POLICIES TO BE FOLLOWED IN RATE MAKING

1. The United States Supreme Court holds that a rate-regulating body cannot compel a public utility to furnish service at a rate that merely returns the increment cost of the service; also that when a rate-regulating body undertakes to establish a rate for a given

class of service, the costs pertaining to that class of service must first be determined and assigned thereto, and that overhead and general expenses must be fairly apportioned between that class and all other classes.

2. Rates need not be uniform for all classes of service or localities. The same rate of profit is not required on different classes of service. Reasonable adjustments may be made as between classifications taking into consideration varying costs, competition and economic value of the service.

3. No body of consumers should be served at a loss and thereby be a burden to other classes.

4. All consumers can enjoy lower rates whenever the utility serves all possible consumers in a given territory.

5. The larger the consumer the lower the cost, especially when long hours' use of maximum demand at off-peak is attained.

6. A segregated wholesale plan is sound.

METHODS EMPLOYED IN RATE STUDY

In the discussion so far it will be seen that "total cost" and "gross revenue" are used as synonymous terms. In order to arrive at the individual's proportion of this total it is necessary to begin at the top and work down. The serious fault in the past has been the attempt to go from the total business down to the individual at one jump. The total business has been considered as made up of individual consumers rather than of different-sized groups of individual consumers in different localities and under different conditions, as they actually are. Proceeding from this viewpoint, they may then be thought of as minor groups depending on the larger ones, and so on down until finally the individual is reached as simply a part of a minor group or classification. Consumers should first be grouped geographically and costs apportioned on this basis. These costs must then be subdivided among the smaller groups or classes, and so on until the individual is reached and dealt with according to his location and the class to which he belongs.

A consumer or group of consumers will not take service if it costs much more than they can produce it for themselves. This cost to produce may be used as the measure of individual or group "value of service."

The "total cost" should then be apportioned among the geographical groups so that each group pays in proportion to its "value of service." This gives a combination of "costs" and "value of service" that is desirable. The larger groups should then be apportioned in the same way and the operation continued until the individual is reached. The total local class cost among individuals in the various classes should then be apportioned on the individual's "value of service."

This method gives the individual the benefit of class grouping and also the benefit of combining all classes in a given locality into one group, and as locality groups are combined he receives additional benefit.

CONTINUOUS COST CHECK

To illustrate, we have three steam-electric generating stations located in three towns and owned by the company doing the retailing in the three places. (See Fig. 1.) The three plants feed into a system owned by another company, and they serve fourteen towns and villages in all. Energy is also purchased by the transmission company from an outside source. Each of the three generating plants handles central-station heating, and the expense of the heating service is kept separate as far as possible. All plant-operating expenses incurred in producing electric energy are charged against the cost of producing energy for the entire system. All the energy produced by the three plants is also charged against the entire system, as is the purchased energy. To this total is added the operating expense of the transmission system. This is called the production cost for the entire system. To this the overhead expense of the power plants and transmission lines is added. The next problem is to apportion this "total cost" among the fourteen towns in an equitable manner. All towns are treated alike, no allowance being made for the presence

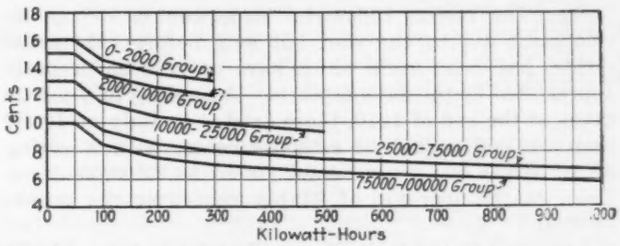


FIG. 4—AVERAGE POWER RATES FOR VARIOUS OPERATING GROUPS
Minimum bills are omitted from consideration. See the table for these minimums.

of a generating plant in a town. A common wholesale sliding scale rate for all towns, such as that in the table on page 425 (or we could use instead a ratio or percentage), based on the town's "value of service," is applied to the total energy used by each town on the system. The sum of all these values divided into the value for any particular town gives that town's proportion of the "total cost" each month. The wholesale sliding-scale rate, based on the town's "value of service," is used primarily as a factor to arrive at the proportion of the "total cost" for any given town. It is immaterial what figures are used in the rate to obtain this proportion so long as they are based on the value of service to that particular community. Since the plants in three towns are owned by the local distribution company, each generating town is credited each month on its wholesale power bill with the amount of plant overhead expense charged into the system each month. This is in the nature of a rental to the transmission system and necessary to get the total power-plant charges into transmission costs. Each town therefore stands its correct share of all expense. These cities and villages are patrons of the power plants and transmission lines, just as much as the individual consumers are the patrons of the distribution systems.

The general plan of charging a common wholesale sliding-scale rate to towns of all sizes within a given group, and retail rates based on the average wholesale rate to each town, proves reasonable and popular with the individual consumer. It stops all arguments between towns, since both wholesale and retail rates are the same in towns of the same size or using the same amount of energy within the same group. The larger the town or the more energy used by any town, the lower will be the wholesale and retail rates.

An example of a rate schedule built up on the foregoing plans is that in Fig. 2, in which the relation of the retail lighting and power rates to the wholesale rate for various groupings is shown. Figs. 3 and 4 show the average retail rates for power and lighting for various assumed consumptions. The curves omit consideration of minimum rates, which are shown in the schedules in the table I.

Readers' Views and Comments

Italian Electrical Industries Show Rapid and Continuing Growth

To the Editor of the ELECTRICAL WORLD:

SIR: The Italian industries underwent a strong development during the war, but long before 1914 great strides had been made which have never been properly appreciated by the outside world. According to a census taken at the end of 1910, there existed in Italy no fewer than 243,000 industrial establishments, with a rating of 1,570,000 hp., giving employment to 2,300,000 men. This was an increase of 34 per cent over the census of 1901.

Leading in industrial life was Lombardy, with 41,030 plants, followed next by Piedmont with 26,336, Tuscany with 22,558 and Venice with 20,900.

According to statistical returns by the Department of Commerce, the following capital has been invested in new industries in Italy during the period from 1915 to 1918: 1915, 79,000,000 lire; 1916, 235,700,000 lire; 1917, 1,288,479,000 lire; and in the year 1918, 2,949,000,000 lire.

The consumption of electric power is perhaps the best measurement of the development of Italian industry. The respective figures (in thousands of kilowatts) are: 1911-12, 17,968,257; 1913-14, 23,119,303; 1917-18, 33,915,890.

Like Switzerland, Italy is trying its best to become independent of foreign coal by means of electrifying the state railways. At the present time the entire electric railway lines in Italy have a total length of only 350 km. (218 miles), and the only great line for the electrification of which preliminary technical and financial steps have been taken so far is that of Modane-Turin-Genoa.

In 1919 the largest capital—435,000,000 lire—was invested in mechanical and metallurgical industries. The great Italian banks supported this movement in a most liberal way. The result is that Italy is today much less dependent upon foreign importation. The chemical industry especially has undergone the greatest changes, though it is as yet doubtful whether the electrotechnical industry will be able to supply the requirements of the home market.

One of the highest Italian authorities on technical questions, Professor Beluzzo of the Milan Polytechnic Institute, recently said, in a speech at Milan, that Italy was bound to develop by all available means the electric resources of the country. Numerous concessions for the utilization of electric power have been asked and granted of late. At present there is only 1,000,000 hp. of electrical energy developed in the country, while more than 5,000,000 hp. is available.

Another industry which did not exist before the war has since made considerable progress—that of the manufacture of magnets and sparking devices for internal-combustion motors. This industry has meanwhile assumed such proportions that it not only supplies the entire home market but also ships considerable quantities abroad. Furthermore, the manufacture of electric accumulators, which largely increased during the war, is making steady progress, thanks to the existence of lead-ore deposits in a great many parts of the Italian peninsula.

A great drawback, however, in the development of the Italian industries is the fact that the country has to import almost every class of raw materials, including coal, foundry iron and, to a very large extent, even ore.

Münsinger-Berne, Switzerland. HENRY L. GEISSEL.

Improving Power Factor by the Use of Induction Motors

To the Editor of the ELECTRICAL WORLD:

SIR: Referring to the comments by Quentin Graham appearing in the ELECTRICAL WORLD of Jan. 15, page 149, may we say that we did not aim to extol the induction motor synchronously operated as superior to a motor of synchronous design, but rather to demonstrate the complete feasibility of such operation where starting loads are moderate, running loads not in excess of rating and a wound-rotor machine available? These conditions are not found simultaneously in all motor applications, but perhaps they exist in enough to warrant giving publicity to the satisfactory synchronous operation of induction motors of ratings less than those available in lines of synchronous motors. In regard to Mr. Graham's statement that 100 per cent of magnetizing ampere-turns are required for stable synchronous operation, our article shows that it is quite possible to obtain this, without exceeding heating limitations, owing to the absence of induced rotor currents.

Yale University, New Haven, Conn. RUSSELL G. WARNER. A. E. KNOWLTON.

More Testimony that Causes of Fires Are Not Accurately Reported

To the Editor of the ELECTRICAL WORLD:

SIR: I have read with much interest the article on page 277 of the Jan. 29 issue of the ELECTRICAL WORLD under the title "Society for Electrical Development Attacks Fire Underwriters' Figures." I should like to say that from my own experience I know that in many cases the contention that fires result from electric wires is "all bunk." I put in one year's time in a fire department and was always present when the cause of each fire in our district was looked for. The first procedure was to see whether the house or building was wired, and if it was, the cause of the fire was set down as "crossed wires." These reports, I suppose, came to the attention of the insurance companies. I know of one instance reported as crossed wires when the house was not wired. In another instance there was a 3-in. hole in the chimney and the fire had done some damage around the chimney but was not near the electric wires. I told this to the captain, but the cause of the fire was reported as "crossed wires."

I am convinced that in 98 per cent of the fires attributed to crossed wires the cause given is guesswork. It is safe to say that crossed wires did it, since few persons know that the average wire will hold a closed contact and blow the fuse without throwing sparks. I believe cigarettes cause 90 per cent of our fires. I have known within the last three years of three fires in the factory in which I am employed started by cigarettes.

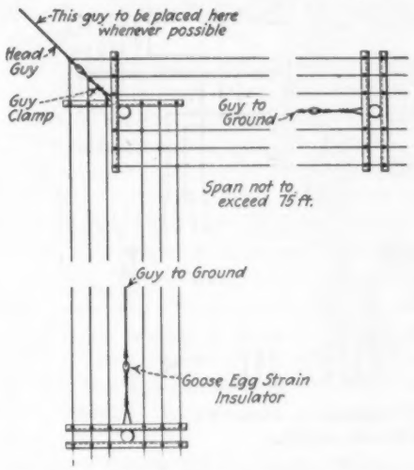
Chicago, Ill. A READER.

Station and Operating Practice

A Department Devoted to Problems of Installation, Operation and Maintenance of Equipment for Economical Generation and Distribution of Electrical Energy

Making Better Line Corners

DOUBLE-ARMING corner poles helps to make pole lines look "sloppy" and makes them dangerous to work on. The accompanying drawing shows a neat corner that provides ample working space if cross-arms having at least 30-in. pole-pin spacing are used. The line strains are taken on the adjacent poles by double-arming and guying. The spans around the corner can be shortened and slacked to ease the strain. The corner-pole guy will carry only a small strain if the work is done properly. Where heavy leads are involved special cross-arms of heavier cross-section are preferable to double arms because of the cleaner corner poles which the single-arm construction gives.


This guy to be placed here whenever possible
Head Guy
Guy Clamp
Guy to Ground
Span not to exceed 75 ft.
Guy to Ground
Goose Egg Strain Insulator

A LINE CORNER THAT PROVIDES AMPLE WORKING SPACE AND SAFETY TO LINEMEN

Chicago, Ill. FIELD EDITOR ELECTRICAL WORLD.

Percentage of CO_2 Is Not Final Test of Good Combustion

MANY power-plant engineers do not place much confidence in CO_2 readings and make it a rule never to allow the CO_2 present to exceed 10 to 12 per cent or even 8 to 10 per cent. Under these conditions there is likely to be a waste of fuel due to the avoidable escape of sensible heat up the chimney. In contrast with these there are authorities who claim that there is no danger of having combustible gases escape unconsumed before CO_2 reaches a point above 15 per cent.

The fact of the matter is that combustible gases may appear with any percentage of CO_2, and dependence on CO_2 records alone is therefore decidedly misleading. It is quite possible to have large volumes of combustible gases (CO, CH_4 and H_2) present simultaneously with a low percentage of CO_2 as well as a high percentage of CO_2. For example, if the fire in one part of the furnace is very thick or dirty, CO would be generated in that part and escape unburned because not enough air would be going through. If, at the same time, there is an air hole in another part, air would rush through unused. Under these conditions CO would be present at the same time that a low CO_2 reading indicated excess air.

The percentage of CO_2 for economical combustion may vary considerably from time to time in the same furnace with the rate of combustion, method of firing, thickness of the fire bed, distribution and character of the fuel, draft, formation of ashes, dirt and clinkers, and many other influences which are subject to irregular variations and which have a decided effect upon the completeness and efficiency of combustion with any given air supply.

Generally speaking, low CO_2 indicates excess air, but it may also indicate that the air is poorly mixed, giving rise to a simultaneous formation of CO. It is therefore not desirable to attempt to secure a high percentage of CO_2 by cutting down the draft alone. A high percentage of CO_2 can be obtained with practically any draft, so long as it has the proper relation to the fuel-bed resistance. On the other hand, the losses due to the formation of combustible gases which are allowed to escape up the chimney without being burned are frequently much greater than the losses due to excess volumes of air, because it is quite possible to reach a very high percentage of CO_2 while simultaneously producing large volumes of combustible gases.

Insufficient air supply is the most general cause of the presence of CO in the stack. CO may, however, be present owing to the poor design of the furnaces, improper methods of firing, the coal being of a character not adapted to the equipment with which it is burned, poor mixing of the combustible gases with the air, and low furnace temperature which causes gases to be cooled below the ignition point before combustion is complete.

Mono Corporation of America, New York City. OLOF RODHE, Chief Engineer.

Standardized Meter Test Board Speeds Up Laboratory Testing

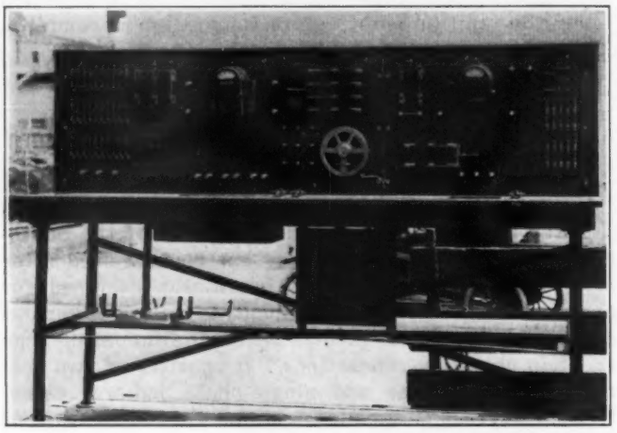
A BOARD for quickly testing watt-hour meters in the laboratories in outlying districts of the Southern California Edison Company has been evolved after several years of trial. This board was designed for applying the necessary testing loads to meters of various current and potential ratings with a minimum of time spent in changing connections. It consists of two sections, for polyphase and single-phase meters respectively. Current is supplied from an open-delta bank of transformers wound for 110 volts on the high-tension side and 11 volts on the low-tension side. Loading the meters by low-voltage current not only saves energy but makes possible the use of small iron-wire coils for loading, with a wide range of combinations.

Compartments are provided in the front shelf for the rotating standard meters used in testing. These standards are started and stopped by telegraph keys connected in their potential circuits—a convenience which will be appreciated by testers using the more cumbersome pendent-type switches generally employed for this purpose.

The single-phase board, on the right, has a current control switch on the left of the meter and two double-throw switches on the right for the potential leads. By the use of these switches it is possible to obtain either 110 volts or 220 volts in phase with the current or leading it 60 deg., the latter method being used for adjusting meters at 50 per cent power factor. Any desired combination of loads is obtained by the single-pole switches, the lower row of which controls the light-load resistors and the upper row the heavy load. With these switches set as required by the meter size, transition from light to heavy load is quickly effected by operating the double-pole, double-throw switch on the left.

This switch also automatically cuts in the light-load or heavy-load coil of the standard meter, making it impossible to burn out the small-capacity coil by throwing the heavy load on it.

The polyphase board, on the left, is arranged for testing with a balanced three-phase load at any power factor. Three similar groups of resistances are provided, connected in closed delta, and controlled by the single-pole switches at the left of the panel. Any power factor from 0 to 100 per cent is obtained by a phase shifter in the potential circuit. This is installed behind the board, the rotor being connected to a graduated dial on the front of the panel. A four-pole double-throw switch transposes the phase connections of the meter elements so that the meter may be calibrated on both phase rotations. Owing to the use of low-voltage current for the series coils it is, of course, necessary to disconnect the potential coils at the points where they are joined to the series terminals and to excite them separately if these coils are tied together according to the practice followed by some companies. However, if the meter has independent connections to potential and current coils no changes are necessary.

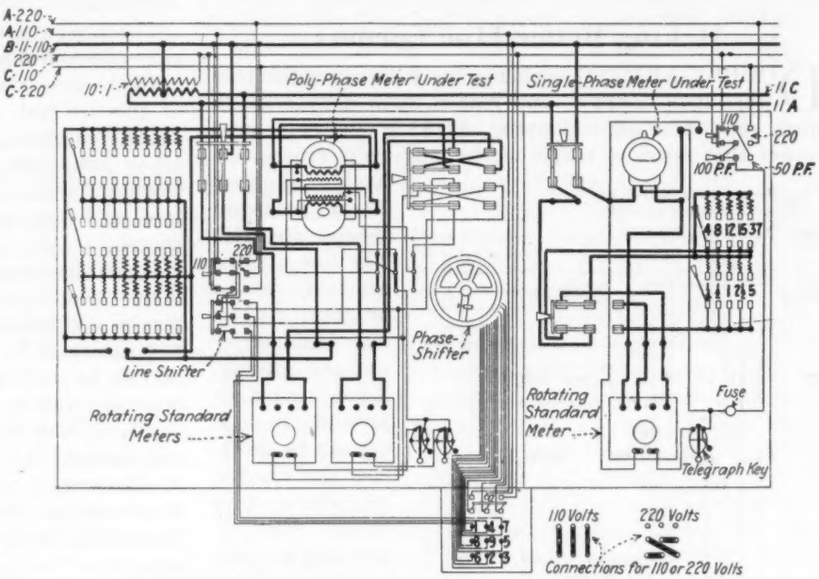


THIS METER-TESTING BOARD IS DESIGNED FOR BOTH SINGLE AND POLYPHASE METERS

HALBERT R. THOMAS,
Meter and Testing Department.
Southern California Edison Company,
Los Angeles, Cal.

Authority and Duties of the Load Dispatcher

AS A LOAD dispatcher is constantly in communication with all parts of a system, he should have complete authority in directing operation in normal or emergency conditions. The dispatcher should direct the loading of all plants as well as of the individual units. Except in cases of emergency, no machines should be started up or shut down without his orders. He should be furnished with curves or other data showing the proper loading point on all machines to obtain maximum efficiency. He should at all times have knowledge of the available kilowatt-hours in storage reservoirs, and no water should be taken from ponds or flumes without his orders. There should be gaging stations showing both rainfall and second-feet flow conveniently located throughout the system with telephone connection to the dispatching office.



METER TEST BOARD WIRED TO PREVENT POSSIBILITY OF BURNING OUT STANDARD METERS

The switching of all lines should be handled by the load dispatcher. In case it is decided to de-energize certain lines for repairs, notice should be given to the dispatcher, who should investigate the load conditions and when necessary take the matter up with the customers whose service would be interfered with and decide whether or not the work can be done. No apparatus or part of the station equipment, such as transformers, generators and oil switches, should be taken out for repairs or dismantled without the knowledge of the dispatcher. Where work is to be done the dispatcher should issue to each station where switching is necessary the proper clearance order, and all such orders given by telephone should be repeated to avoid any possibility of a misunderstanding.

In the event of transmission-line trouble the dispatcher should handle the sectionalizing and testing of the lines. He should send out patrolmen or repairmen to make temporary or permanent repairs. All employees, irrespective of departments, are subject to call from the load dispatcher in case of an emergency. If trouble occurs and the dispatching office cannot be communicated with, the sectionalizing and testing of the lines should be carried out according to a prearranged schedule.

A complete log recording all operating details should be kept. A copy of power-house logs should be sent to the dispatcher, who should compile certain records pertaining to the amount of power generated and to the class of service. The dispatcher's log should show the number of kilowatt-hours generated at each station every hour, and from those readings the daily system load curve sould be made. The amount of water added to or taken from storage reservoirs should be recorded each day. Detailed reports of the line troubles should be kept, and from these a monthly report of the interruptions to custoners should be made out.

A copy of all periodic reports covering the inspection of equipment should be sent to the dispatcher. In case these reports show any apparatus in need of attention, he should take the matter up with the proper authorities with the view of having the condition remedied.

Wherever possible the load dispatcher's office should of course be at or near the center of distribution. Private telephone lines should be maintained between the dispatching office and all stations, and as often as possible there should be connections to the Bell telephone lines as well. The dispatcher should have telephone connection with patrolmen living along the transmission right-of-way in order that these patrolmen may be notified immediately following a case of trouble in their territory. In the dispatching office there should be displayed a map or dummy board carrying a layout of the system and showing the position of every line and switch. The immediate operation of the system can be conveniently followed by a color scheme of plugs or lights.

M. M. RODDEY,
Superintendent of Operation.

Tennessee Power Co.
Cleveland, Tenn.

Securing Good Parallel Operation of Alternators

FOR satisfactory operation of alternators in parallel the chief requirements are: (1) Equal average speed of engine; this means rather heavy flywheels and good valve setting. (2) Fairly sluggish governors which will not respond too quickly to slight changes of load. (3) Some means to choke out any "pumping," such as solid pole shoes, or copper dampers if the poles are laminated. (4) Speed drop from no load to full load the same in each engine, otherwise they will not divide the load properly. Requirements Nos. 1 and 3 must be taken care of by the manufacturer, but Nos. 2 and 4 can be adjusted after installation.

If the engine regulation is too "close"—that is, if speed does not drop appreciably as load comes on—good parallel operation is impossible. Suppose, for example that two engines driving generators in parallel ran at exactly the same speed at full load as at no load. There would then be no tendency for either to "get out from under" when load came on and thus give part of the load to the other machine. Consequently the load might go to either one and not be divided between them. When paralleling a slow-speed unit with a high-speed unit it is almost always found that the high-speed machine tends to take the load away from the low-speed unit, particularly on sudden load increases. This is because the high-speed machine is usually quicker to govern. If this is objectionable, it can be overcome by placing dash-pots on the governor of the high-speed machine to make it more sluggish.

Trouble from pumping is likely to occur if either engine shows unequal indicator cards for the two ends of the cylinder. Such poor adjustment causes uneven speed of rotation and can be remedied by proper setting of the valve gear.

The only way to make each machine take and hold its share of the load is to make the engines hold up speed equally. Little or nothing can be accomplished by juggling the field rheostats. Increasing the field strength of a direct-current machine makes it take load, but this is not true of an alternator. Increasing the field strength makes the alternator generate more voltage, but the extra voltage is used in circulating wattless current through the stator windings of both machines. Hence the ammeter readings will change but the wattmeters will not. To reduce the wattless current between the two machines to a minimum their field should be so adjusted that the two machines give the same voltage at no load. A few trials will show just where the rheostats should be set for regular service conditions.

If cross-current or pumping action is troublesome on two machines having separate exciters, it is well to parallel the exciters or excite both alternators from one exciter. Connecting together two rotors in this way causes them to act as dampers on each other and helps considerably to kill any "swinging" of the load.

JAMES DIXON.

Reliance Electric & Engineering Company,
Cleveland, Ohio.

Cost Estimate for 66-Kv. Spur Line $6,630 per Mile

BASED on extended construction experience, the New England Power Company, Worcester, Mass., recently prepared the accompanying estimate of cost for building 3.06 miles of a 66,000-volt branch line on a 100-ft. right-of-way in the Pepperell district of northern Massachusetts, using steel wishbone cross-arms, wooden poles, No. 2 copper wire and four-disk and five-disk suspension insulators. The poles are set twenty-eight to the mile. These values represent what a line would cost in December, 1920.

ESTIMATED COST OF 66,000-VOLT BRANCH LINE

Costs for December, 1920.
Line has twenty-eight wood poles per mile.

Clearing	$2,140
Pole erection	3,160
Haulage and handling	518
Power wire	2,550
Power insulators and hardware	4,650
Crossarms and fittings	1,565
Stringing power wire	622
Telephone circuit (on poles)	1,460
Special work	1,132
Right-of-way	2,560
Total	$20,357
Per mile	6,630

It will be noted from the table that of the total cost, which averages $6,630 per mile of line, the cost of insulators and hardware for the power circuit amounts to 23 per cent, while the power wire amounts to 12.5 per cent and the cross-arms with their fittings cost almost 8 per cent. The second largest item is that of the poles and their erection, which amounts to 15.5 per cent.

C. R. OLIVER,
Construction Engineer.

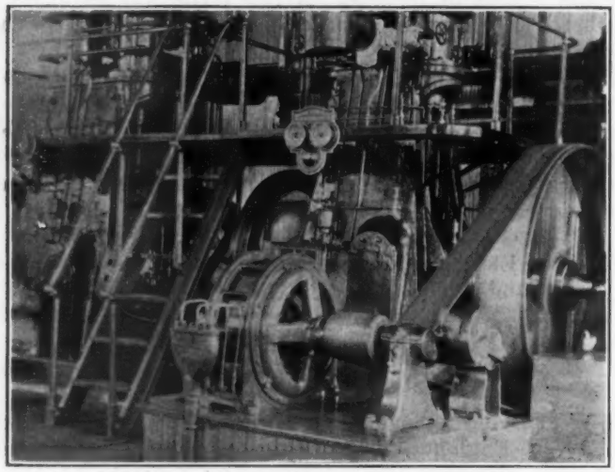
New England Power Company,
Worcester, Mass.

Industrial Applications

The Economical Utilization of Electrical Energy in Mills and Factories, Together with Practical Details of Installation, Control, Testing and Repair of Equipment Required

Motor Drive for Compressor Takes Little Space

THE three-phase motor driving an ammonia compressor in a refrigerating plant on Cape Cod, Mass., takes very little floor area. It drives through a short wide belt with idler adjustment. This mounting renders the motor unusually accessible and provides a flexible



COMPACTNESS AND ACCESSIBILITY COMBINED IN THIS COMPRESSOR DRIVE

drive from a pulley of small diameter to a pulley virtually as large as the compressor flywheel. The motor is mounted on a low platform, allowing very short wiring connections from a vertical pot-heat connected with the conduit system of the plant. EUGENE CARPENTER.
Cape & Vineyard Lighting Company,
Falmouth, Miss.

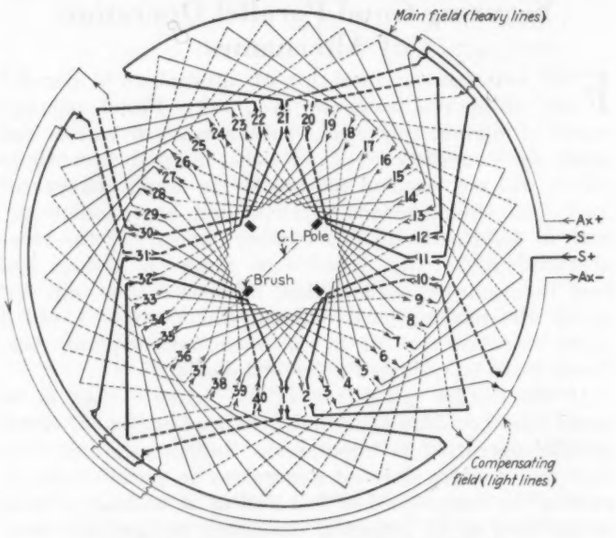
Overheating of Improperly Connected Series Alternating-Current Motor

TROUBLE on a series motor with a field winding in slots similar to the stator of an induction motor and with non-shifting brushes recently came to the writer's attention. This motor had been rewound, and when an attempt was made to start it the motor sparked at the brushes and the armature winding heated excessively. An investigation revealed that the stator winding had been put on in the wrong position without regard for the position of the brushes.

The motor is a single-phase, series commutating motor for 150 volts alternating current or 300 volts direct current. It is used to drive a blower that ventilates the main motors on an electric locomotive. The stator or field is similar in construction to the stator of an induction motor—*i.e.*, laminated, with partly closed overhanging slots, evenly distributed around the periphery. The armature is lap-wound and is virtually the same as any direct-current armature. The motor has four brush arms rigidly fixed to the front bearing bracket, and these arms cannot be shifted.

The stator had forty slots and forty two-layer diamond-shaped coils with two turns of $\frac{1}{16}$-in. x $\frac{1}{2}$-in. bare copper strap per coil, each individual turn being insulated, so that one strap could be threaded in at a time. The pitch was 1 and 10. The coils were connected up into two separate windings, the main field or torque winding and the auxiliary or compensating winding, as shown in the drawing, the heavy lines representing the main field and the light lines the compensating winding.

In stripping the motor no attention had been paid to the location of the slots containing the main coils, or to the slots in which the outside leads were taken off the coils. When the winder put the coils back he had not tried to get the coils in the proper position as regards the brushes. In order to see if this had resulted in placing the winding in the wrong position, the main winding was traced out and marked with chalk, then the front end bracket was put on. It was found, as suspected, that the brushes were not on the center lines of the main poles where they should have been. Further to check this theory of shifted brushes the proper main coils were marked off; then the bolts were removed and the front bracket was rotated until the



CORRECT CONNECTION FOR A SINGLE-PHASE, SERIES COMMUTATING MOTOR

Four-pole motor for 150 volts alternating current or 300 volts direct current. Has forty slots and forty coils of two turns each (only one is shown). Full lines represent top half of coil, dotted lines bottom half. Pitch is 1 and 10. Center line of brushes should pass through center line of slots 6-16-26-36.

brushes were brought on the center lines of the existing poles as marked. The bracket was then held in place with "C" clamps, and when current was applied the motor ran correctly on both alternating current and direct current.

Accordingly the motor was reconnected as shown in the diagram with the center line of each main pole passing through a brush. The mistake the winder had made in connecting up was to use the bottom lead in slot 14 for "S+" instead of the bottom lead in slot 11 as shown. As the rest of the winding was picked up in proper order, the finished winding was four slots out of line, which had the effect of shifting the main poles 27 mechanical degrees. The brushes should be set on the center lines of slots 6-16-26-36, which are also the center lines of the main or torque poles. Instead, the winder had the pole center lines on slots 9-19-29-39, which brought coils short-circuited by the brushes into an active field. Consequently these coils had large currents induced in them and caused the heating and sparking experienced.

This experience points out the lesson that when rewinding motor stators of the single-phase type the slots in which are the coils containing leads to outside connections should be marked with a steel stamp and a drawing made showing the layout and number and the location of the leads, so that the winding can be put back in the proper position.

A. C. ROE.

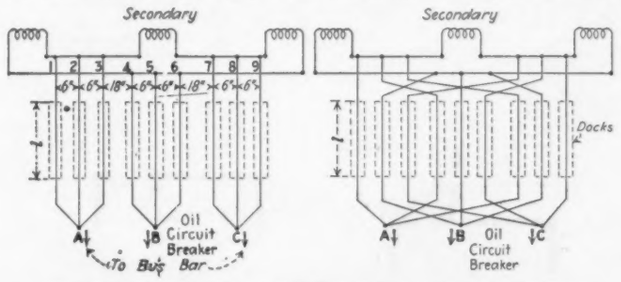
Detroit, Mich.

Current Unbalance in Furnace Leads Reduced with Reactors

A CASE of current unbalance in the secondaries of furnace transformers was solved by the writer through the use of laminated iron reactors having a high permeability. It was not possible to use any of the ordinary methods of transposition or interlacing of these bus cables.

The installation consists of two banks of transformers, each bank made up of three 2,500-kva. single-phase transformers; secondary, delta; primary, delta; primary, 44,000 volts; secondary, 2,200 volts; 60 cycles. The two banks operate in parallel, and with 75 per cent full load the cables on the secondary side of the transformers connecting the low-tension bus as shown in the wiring diagram became dangerously hot.

The size of each cable is 750,000 circ.mil.; that is, the total for each phase is 2,250,000 circ.mil, which should be of ample capacity without any undue heating for the particular load requirements. As can be seen in the wiring diagram each cable has a separate 3-in.

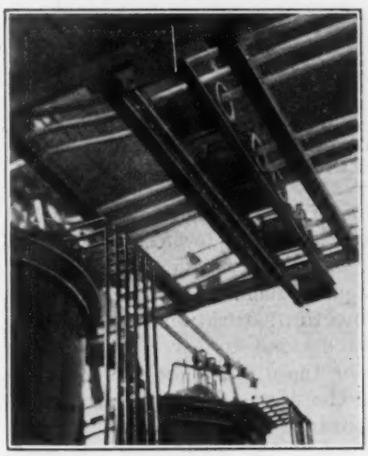


EXCESSIVE HEATING MAY RESULT FROM UNBALANCE IN FURNACE TRANSFORMER SECONDARIES

On the left is shown an installation which gave trouble from heating in cables 3, 4, 6 and 7. On the right is a method of transposition which would have eliminated this unbalance. This method was not feasible because of construction difficulties.

fiber duct. Centers are 6 in. apart, and each phase is 18 in. from the next. The length of the cables from the busbar to the transformers is approximately 75 ft.

At first some thought was given to transpose the cables, which would have virtually neutralized the inductive effects, making the application ideal had it not been that constructional difficulties made this virtually impossible, the distance being too short for a transposition. When a transposition is feasible it should be within each phase group of the conductors so that each conductor will have an equal impedance and there will be no excessive heating in any one of the conductors. The aim is to have each cable of the group kept in the same average relative position over the run, and if this condition is obtained, then each cable will take an equal current and there will be no excessive heating. A scheme was drawn up, as shown in the wiring diagram, whereby the leads would be interlaced. In this way the inductance of the leads would be kept at a minimum because of the subtractive effects of the mutual inductance of adjacent cables of opposite polarity. Because of this the resulting inductance of a negative cable with a positive cable placed on both sides of it would be considerably reduced by the mutual inductance subtracting from its self-inductance. The degree to which the current could be made to distribute equally among the parallel conductors depends upon the extent that the interlacing makes the circuit symmetrical. By referring to the diagrammatic layout it will be noted that the ducts are 6 in. apart, center to center, and in the same plane. If these ducts had been arranged in three sets, each set forming an equilateral triangle, and the ducts instead of being 6 in. apart had been placed side by side, the mutual induction would have been materially lessened.



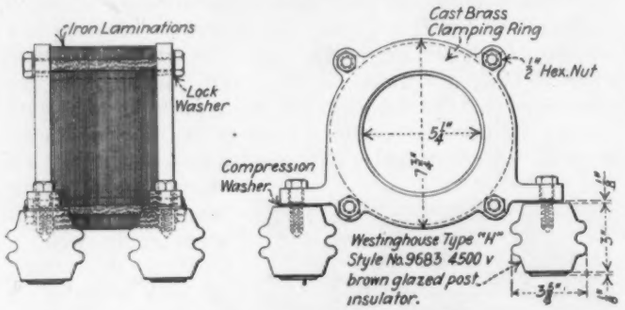
REACTORS WERE LOCATED MIDWAY BETWEEN TRANSFORMERS AND POINT WHERE CABLES ENTER DUCTS

In this case all of the above methods would have been impossible to adopt, so that an alternative scheme had to be thought of, which was the introduction of reactances in the cables taking more than their proper proportion of current. This was accomplished by surrounding the cables over a given length with laminated iron having a very high permeability. The method has been successfully used in different installations to balance the voltage applied to rotary converters. The principal objection to it is that the balance is obtained by increasing the total reactance of the system, which in some cases would be very objectionable. Applying reactors to the cables induces a counter-emf. in the cable which is proportional to the current flow and the length of the core of the reactor.

This counter-emf. is directly opposed to the flow of current, and its function is to oppose part of the main flow of current and increase the flow through the cables that before were only partly loaded. By examining the sketch which illustrates the general construction of the reactor it can readily be seen that the designer has been very liberal with the iron. This was done to insure that the iron should not be oversaturated when the cables were carrying full load; otherwise the effective reactance

would decrease greatly when the cables were carrying an overload. Obviously such a reactor as that described should be so designed that its entire working range will fall well below the knee of the saturation curve of the iron.

Calculating the cores from a basis of 700 amp., the ampere-turns in the reactor are 700 amp. × 1 turn = 700 ampere-turns. The circumference of the core is 20.4 in., or approximately 3.43 ampere-turns per inch of



REACTORS WHICH WERE BUILT AND USED TO DECREASE CURRENT FLOW IN UNBALANCED FURNACE CIRCUIT

core circumference. The flux density is therefore 37,100 maxwells per square inch. High-grade sheet iron such as was used can be readily operated at a density well over 100,000 maxwells per square inch. The iron is therefore operated well below the saturation point. As a factor of safety it was decided to leave ample room around the conductors for the dissipation of heat; consequently this increased the diameter of the core, there being virtually 2 in. clearance from the outside of the cable insulation to the core. By varnishing the laminations the iron losses, eddy currents and hysteresis were kept down to a minimum, and in fact they are negligible when compared with the total output of the transformer.

The accompanying figures will help to illustrate the effect of the reactors in bringing about a comparatively even current distribution in all the conductors.

CURRENT IN THE CABLES BEFORE INSTALLATION OF REACTORS

Phase A		Phase B		Phase C	
Cable	Amp.	Cable	Amp.	Cable	Amp
No. 1	617	No. 4	735	No. 7	670
No. 2	522	No. 5	556	No. 8	425
No. 3	778	No. 6	626	No. 9	708

CURRENT IN CABLES AFTER INSTALLATION OF REACTORS

Phase A		Phase B		Phase C	
Cable	Amp.	Cable	Amp.	Cable	Amp.
No. 1	669	No. 4	639	No. 7	660
No. 2	609	No. 5	639	No. 8	619
No. 3	639	No. 6	639	No. 9	638

From the table it will be seen that a perfect balance was obtained in phase *B*. This could also have been accomplished in phases *A* and *C* had two reactors been used as in phase *B*. Phases *A* and *C* were considered close enough for all practical purposes; that is, the cost of the extra reactors would not offset the gain brought about by having an absolutely even current distribution in all the cables in phases *A* and *B*.

The lengths of the different reactors to bring about the above results are as follows: Phase *A*, cable No. 3, 5¼ in. Phase *B*, cable No. 4, 2¼ in.; cable No. 6, 4½ in. Phase *C*, cable No. 7, 8½ in.

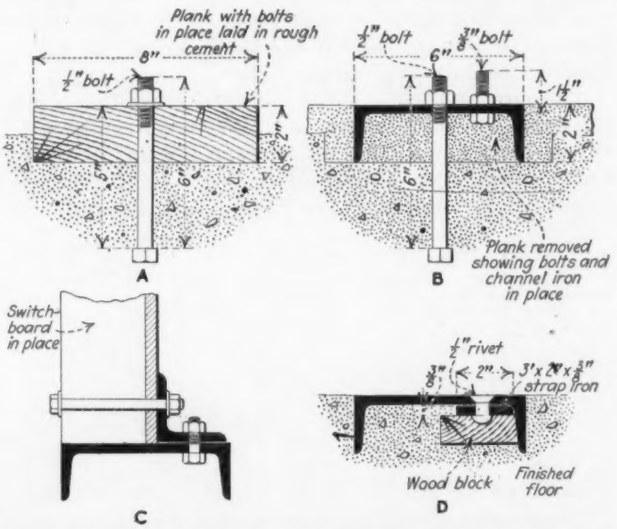
The photograph shows the installation of the reactors. They are mounted on a channel-iron rack hung under the cables midway between the transformers and where the cables enter the ducts. The reactors are insulated from ground with 4,400-volt post-type insulators.

Trail, British Columbia. R. H. N. LOCKYER.

Secure Method of Mounting Switchboard

FOR securely fastening a channel iron to be used for the base of a switchboard on a concrete floor the writer has used the method illustrated in the accompanying drawing. This gives a very firm support to to the switchboard framework. The channel iron is held down by means of bolts inserted in the concrete floor. The bolts which hold the supporting feet for the switchboard may be inserted at the time of laying the floor or, by use of a special construction, may be inserted at any time afterward. The first step to be taken is to insert a plank 8 in. wide and 2 in. deep into the forms at the place where the switchboard is to be set. This plank has bolts through it and extending downward as shown at drawing *A*. These bolts are used to hold the channel iron in place. An 8-in. plank is selected if a 6-in. channel iron is to be used because it leaves a space on each side of the iron so that the iron may be wedged to one side or the other to correct any irregularities which are present in the iron. When the rough pouring of the floor has set, the plank is taken up and the channel is put into place after filling the slot in the floor with soft concrete so that the underside of the channel iron will be filled. The holding-down bolts are spaced so as to come directly in the center of a panel. They should not be placed farther than 4 ft. apart.

Before putting the channel iron in place ⅜-in. bolts are inserted in holes drilled at the places where the



DETAILS SHOWING HOW CHANNEL-IRON BASE FOR SWITCHBOARD IS FASTENED IN FLOOR

feet for supporting the switchboard will come, as shown in drawing *B*. In case it is not known exactly where the switchboard panels will be in the future, the construction as shown in *D*, may be used. In this case a strip of 2-in. x ⅜-in. iron is riveted to the inside of the channel before it is put in place. It is then put in place

with a piece of ⅞-in. board underneath this strip. When the location of the support for the board is determined upon, holes may be drilled through the channel iron and the ⅜-in. strip, and these holes may be tapped to receive the bolts which will hold down the feet of the switchboard support. The addition of this strip of ⅜-in. iron makes the section sufficiently thick to support the switchboard. With the channel iron alone the section would be rather thin. The wood strip underneath allows the drill to pass through the iron without cutting into the concrete.

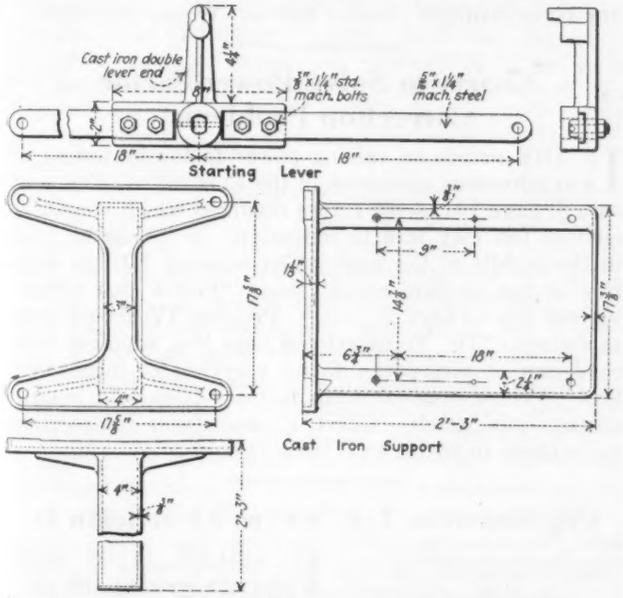
JOHN F. HANLEY.

Lawrence, Mass.

Ceiling Mounting for Large Compensators

IN ORDER to save space compensators are mounted in the ceiling in the factories of the Dayton Engineering Laboratories Company, Dayton, Ohio. The supports are made in two sizes, respectively, for motors of 30 hp. to 100 hp. rating and motors of up to 25 hp. rating.

A drawing of the size used for motors of from 30 hp. to 100 hp. is shown here. The support is a cast-iron bracket, 2 ft. 3 in. long, drilled to be fastened to the ceiling and with holes for bolting on the compensator. In order that the motor may be started up from the floor, a special lever is made which is attached on to the shaft where the ordinary starting lever is fastened. This lever is moved by chains which hang down within reach of the operator on the floor. A third chain is



CAST-IRON CEILING SUPPORTS FOR COMPENSATORS OF 30 HP. TO 100 HP.

attached to the latch of the compensator for tripping it out when it is desired to stop the motor.

Mounting a compensator on the ceiling in this manner not only saves working space but it also eliminates runs of conduit from the ceiling down to the compensator if it is installed at the usual height on a wall or column of the building.

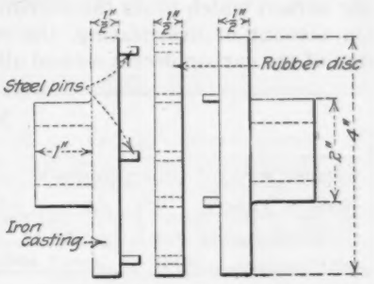
A description of the mounting for motors not over 25 hp. will be given in a later issue.

H. L. BURNS,
Chief Electrician.

Dayton (Ohio) Engineering Laboratories Company.

Flexible Coupling Built at Small Expense

A CONVENIENT and inexpensive coupling of home-made design, as illustrated herewith, is used in the plant of the Chapman Valve Manufacturing Company, Indian Orchard, Mass. The size required for a 2-hp. motor - generator drive cost approximately $3. The coupling is composed of three disks, two of which are iron castings and the third a rubber disk. Steel pins countersunk and headed over are provided as shown for the iron disk, the rubber disk furnishing a seating member for the pins. The arrangement is flexible, and when the intermediate disk is worn the replacement of it is a small matter.



FLEXIBLE COUPLING MADE FOR A 2-HP. MOTOR DRIVE

WALTER B. ATCHINSON,
Electrical Engineer.

Chapman Valve Manufacturing Company,
Indian Orchard, Mass.

Causes of Commutation Troubles

THERE are two common conditions of sparking—first, general sparking, in which the commutator is equally bad all around and the fault is probably in the field or the brush rigging, and, second, local sparking, which is usually due to a rough commutator or armature fault.

In a case of general sparking first examine the field for short-circuited or reversed field coils, check the mechanical centering by measuring the air gap and make electrical balance test. The amount of voltage variation between various pairs of brush arms, when the machine is running separately excited, should not be more than 5 per cent; otherwise there is a good chance of sparking. In two-circuit windings one bad pole does not affect the commutation to a great extent.

If all of these points are good, the sparking may be due to the fact that the field is not "stiff" enough; that is, the neutral shifts with load changes, owing to the armature current affecting the shunt field. The machine can be stiffened in this respect by trimming off the pole shoes to increase the space between them. This method can be applied when there is a non-sparking point for any load. Such adjustments are best made by the manufacturer before the machine is shipped.

The second cause for general bad commutation is that the sparking constants of the machine are bad on account of faulty design or manufacture. In this case commutation must be forced by putting on special brushes. The laminated metal brush was invented to take care of this kind of sparking. Machines as made at present are not liable to require such treatment. It is sometimes hard to distinguish between general sparking and local sparking. Whenever a bad spot shows up in test it is customary to mark the bars by a prick punch at the front ends. Then, if the bad spot shows up again at the same place, after smoothing the commutator, the inference is that the trouble is a local one and may be due to bad soldering or some such reason. A shifting bad spot which travels around the com-

mutator with rotation indicates general trouble and not local trouble.

Graphite brushes will not pick up copper. A carbon brush which picks up copper in little flakes or spots is sure to pit, because the current density will be greater through the flake of copper than through the surrounding carbon which heats the carbon underneath the flake. On account of overheating, the resistance of this section of the carbon decreases and allows still more current to pass. This causes a red-hot spot on the face of the brush, which makes a pit.

A slight prickly sparking on the face of the commutator is one of the earliest and surest signs of high mica. High mica results from inability of brushes to wear the mica as fast as the copper, or from operating with sparking, as on heavy overloads. In high-speed machines violent sparking may be caused by high mica. To prevent this trouble machines with soft brushes should have the mica undercut. High mica cannot be removed by sandpapering. Stoning with a sandstone or carborundum block is necessary. If undercutting is objectionable, owing to dirty surroundings or other reasons, high mica may be kept down by a few hard gritty brushes, scattered over the commutator.

Before investigating local sparking it is necessary to get the commutator in first-class condition and then note the condition of the commutator after short runs, say of one hour. Notice whether any particular bars show marks. Local sparking is generally due to commutator faults, such as loose commutators or bad soldering. Commutator bars are held by two different actions—barrel-stave action and end holding. These must both be good. Poorly soldered joints usually cause a hollow to be eaten out at the bad spot, and this spot travels with rotation so that other spots will start. One spot may be the cause of several others. The travel cannot be stopped by undercutting, but the defective joint must be made good. A completely open-circuited coil burns out the mica between the two bars to which its ends are connected. A reversed coil has the same effect, only very much worse. A short circuit causes the bars at the short circuit to become high.

Other causes of black spots are engine shaft throw, eccentric commutator and imperfect centering of armature in field. Sometimes where shaft throw cannot be eliminated a change to a livelier type of brush holder will enable the brushes to stay with the commutator and thus cure the trouble.

JAMES DIXON.
Reliance Electric & Engineering Company,
Cleveland, Ohio.

Inspection Form for Large Motors

IN MAINTAINING large motors, say of 50-hp. rating and over, the prevention of service troubles warrants a degree of thoroughness in inspection records that would hardly be justified in dealing with small motor units. An example of a form for large-motor inspection is shown. It is 11 in. x 17 in. in size and fits a loose-leaf binder. At the top is a data space about 3½ in. high, filled out in this case for a 25-hp. motor with auto-starter and covering entries giving essential facts about the motor rating, number, etc., with drive particulars. Below are checking spaces for recording inspections.

MOTOR INSPECTION SHEET

PLANT

LOCATION #3 Bldg. Roof "2 LOCATION No. D.P.4 - Middle Cab. FACTORY No. MAKE Westinghouse STYLE No. 160818

SERIAL No. 1594183 TYPE CS H. P. 25 VOLTS 440 AMPS. 29.6 PHASE 3 CYCLES 60 R. P. M. 1160

STARTER Westinghouse Auto H. P. 20-30 AMPS. VOLTS 440 STYLE No. 192523 FACTORY No.

RELAY Westinghouse RANGE 40 AMPS. TO 80 AMPS. # 151643 A FACTORY No. CUT-OUTS AMPS. VOLTS

CONTROLLER

MOTOR PULLEY Rockwood DIA. 11" FACE 10" BORE 2 3/8" MAIN LINE PULLEY Iron DIA. 19" FACE 9" MAIN LINE SHAFT LENGTH DIA.

	MOTOR											STARTER			CONTROLLER		FULL	FRICTION	COMMENTS	
DATE	AIR GAP				OIL			ROTOR		HEATHERS		AUTO		OPEN	CONTACTS		LOAD	LOAD		INSPECTED BY
	Top	Bottom	Right	Left	Front End	Pulley End	Changed	Slip Rings	Brushes	Inside	Outside	Relay Amp.	Neutrals	Fused Amp.	Drum	Fingers	K. W.	K. W.		
												50								

MUCH INFORMATION REGARDING A LARGE MOTOR MAY BE KEPT ON THIS SHEET

Below are checking spaces for recording inspections.

Westinghouse Electric & Mfg. Co., R. P. KING,
East Springfield (Mass.) Works. Works Engineer.

Charts to Solve Power-Factor Correction Problems

IN THE article on raising power factor by means of a synchronous condenser in the ELECTRICAL WORLD of Jan. 8, page 101, some errors occurred which should be obvious but may lead to confusion. In the small type in the middle of the page under example III, the solution of the problem should read: "Follow OLD POWER-FACTOR line (Chart 2), etc." Problem IV should read as follows: "IV. To determine total kva. supplied with condenser at zero power factor carrying no mechanical load: Follow ORIGINAL LOAD ordinate (Chart 2) to CONDENSER KVA. circle (Chart 1) and from intersection trace circle to TOTAL KVA. scale (Chart 2).

Peg Board to Tell Where Electrician Is

WHERE TO FIND THE ELECTRICIAN	
Boiler Room	0
Engine	0
Machine Shop	0
Spike Shop	0
Spike Shop Roof	0
Gas Producer	0
Scrap Pile	0
Scrap Yard Crane	0

PEG IN HOLE TELLS WHERE ELECTRICIAN HAS GONE

IN ORDER to let those who are seeking the electrician in an industrial plant know where he is at any time, a board such as that shown in the drawing, on which are listed the names of the different departments of the plant, with a peg opposite each department, has proved a great saver of time. The names of the departments can be typewritten on a piece of paper, which is then pasted upon a 3-in. board, and the holes are drilled in this board.

Jersey City, N. J. A. E. VERNEY.

Central Station Service

A Department Devoted to Commercial Policy and Management Topics, Including Methods of Increasing the Use of Electric Light, Power and Heat

A System for Handling Customers' Orders with Speed and Efficiency

BY CHARLES A. COLLIER
Assistant to General Sales Manager Georgia Railway & Power Company, Atlanta, Ga.

IN THE ISSUE of the ELECTRICAL WORLD for March 27, 1920, page 740, a method devised by the writer for handling customers' orders by the Georgia Railway & Power Company's contract order department was described in detail. This system made use of forms with carbon copies. The copies were used for departmental instruction and work sheets, one form of application being used for gas orders and another form for electric orders. The system as then described, while far ahead of the one that it superseded, had its limitations and defects, the principal ones being the limited number of legible copies, errors in deciphering the handwriting on the copies and the fact that separate applications had to be written for gas and electric service.

Subsequent to the adoption of the system referred to the gas order and meter division was merged with the electric division of the company. This merger opened up the possibility of a combination gas and electric order. A great deal of thought and study was given to the subject with the idea of improving the method in the following respects:

(1) Speed in handling, (2) legibility, (3) accuracy, (4) simplicity, and (5) reduction in the number of forms and cost of printing and stationery. This study led to the adoption of the revised system now in use. It differs from the system described several months ago principally in the mechanical make-up of the master copy and the copies of the line orders made therefrom. The routine, filing and consolidation of orders and so forth are identical with the methods followed under the carbon-copy system. The master copy shown in Fig. 2 is printed on one side in hectograph ink. The agreement and the place for the customer's signature are on the reverse side. This master copy is inserted in an ordinary typewriter, equipped with copying ribbon and keyboard carrying only capital Gothic letters. A young woman clerk fills it in with the information furnished by the customer which is necessary for all departments concerned. The customer then receives the copy for signature, the agreement covering the furnishing of service, rates and so forth being on the reverse side of the master copy. A credit card is then made on the typewriter, after which the master copy is sent to the credit department for "O.K." Upon being "O.K.'d" it is returned to the contract order department, where a boy runs the master copy through a "Ditto" jelly-pad duplicating machine, making the requisite number of copies on properly colored sheets. The sheets before being run through the machine are in blank, except for the word "original," which is printed on one copy. The color scheme is designed to reduce the possibility of errors, all electrical orders being reproduced on canary-colored sheets, all straight gas orders on blue sheets and all "prepay" gas orders on pink sheets.

The master copy is routed to the bookkeeping department, where it is entered in the consumers' ledger, gas and electrical sheets being consolidated, and is then returned to the contract order clerk. The line orders, of which there are sufficient copies for all departments interested, are released simultaneously with the forwarding of the master copy to the bookkeeping department. The original line order is checked by each department through which it passes, and each department takes and keeps for its record one of the copies accompanying the original. When the original line order is complete and finally returned to the contract record department gas and electric orders are consolidated with the master copy and filed.

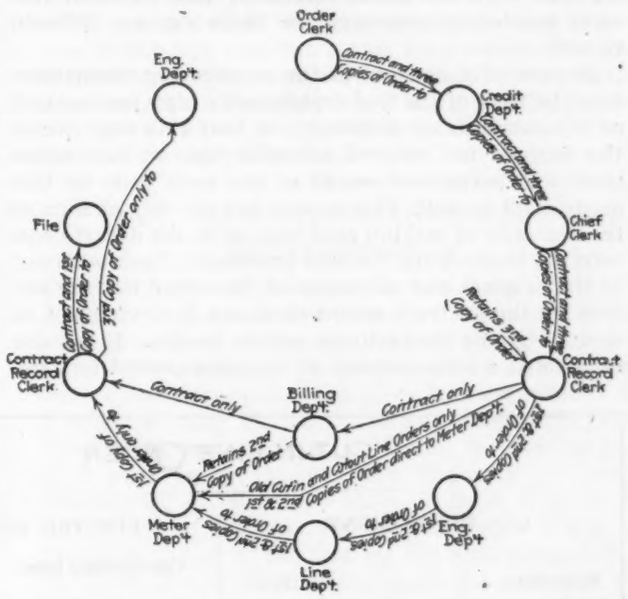

Order Clerk
Contract and three copies of Order to
Credit Dep't.
Contract and three copies of Order to
Chief Clerk
Contract and three copies of Order to
Contract Record Clerk
Pertains 3rd Copy of Order
Contract Record Clerk
Billing Dep't.
Contract only
Contract only
Returns 2nd Copy of Order
Old Cut-in and Cut-out Line Orders only
1st & 2nd Copies of Order direct to Meter Dep't.
1st & 2nd Copies of Order to
1st Copy of Order only to
Contract and 1st Copy of Order to
File
Eng. Dep't.
Meter Dep't.
Line Dep't.
Eng. Dep't.

FIG. 1—ROUTINE FOR HANDLING NEW CUT-IN, OLD CUT-IN AND CUT-OUT LINE ORDERS

Reference to Fig. 4 will give a clearer conception of the number of orders and other details. A street card is also made from the master copy at the same time as the line order and is filed alphabetically and numerically by streets, so that the order clerk has constantly at her elbow a list of all locations that have been cut in. As a customer moves out of and another moves into the same location the old card is destroyed, the new card showing both the present and the former occupant.

The cut-out order is similar in mechanical arrangement to the cut-in order, the same color scheme being maintained; but the order itself is made only half as large as the cut-in order, thereby eliminating the possibility of mistaking a cut-in for a cut-out order, or vice

versa. The mechanical layout of the application is such that when it is folded three times and the cut-out order twice all the information necessary for filing and so forth appears on the face of the order, and it is only necessary to reverse the sheet to get the customer's signature and the rate that is applicable. All sheets are punched before printing so as to fit a standard board file.

The ability to furnish quickly and economically legible copies of the original order in quantities sufficient to enable all departments to retain a copy for their records has eliminated a card index in the contract record department, one in the engineering department, one in the gas shop and a ledger system in the line department, together with the labor, stationery and so forth that were heretofore necessary for these various different records.

In case of a new cut-in the engineering department uses the back of the line department's copy for a sketch of the construction necessary, so that this copy serves the purpose not only of an order but an instruction sheet and permanent record of the work done by that department as well. This system has not only eliminated the necessity of making card indexes in the departments referred to above but has also provided a check whereby, if the original and all copies of the order but the one held by the contract record clerk are lost, virtually no delay in giving the customer service results. It has also eliminated a large number of mistakes caused by careless handwriting, illegibility and so forth, in addition to having speeded up handling customers' orders in the ratio of nearly two to one.

Name COLLIER , MR. C. A.
Location 48 PARK LANE
ATLANTA Ga. Date 11-23-20 192
CLASS OF SERVICE
STRAIGHT GAS ELEC. LIGHT
P////////// E//////////
NEW BUSINESS
Trans. from
TO BEGIN AT ONCE
NEW WIRING REMARKS
O//////
NEW CUT-IN RES.
O//////
RUN GAS SERVICE.

FIG. 3—RECORD FOR CARD FILE
Upper right-hand corner of master copy impression taken on jelly pad duplicating machine.

This revised system was put to its first real test during the moving period last fall, when 360 applications were taken by three order clerks in a working day of seven hours and a half and the majority of the orders were in the hands of the respective departments by 10 a.m. of the following day. The value of the present method of handling is best appreciated when it is understood that the number of employees required for the operation of the contract order and contract record department is five less than was necessary a year ago.

CUT-IN LINE ORDER

GAS DEPARTMENT

Meter Set 192
Company's No. .....
Maker's No. .....
Size .....
Index .....

Work Completed

..... 192
.....
(Signed)

Remarks:

ELECTRIC DEPARTMENT

Construction Dept.

Power Ser. Con. 192
Light Ser. Con. 192
.....
(Signed)

Meter Department

Power Meter Inst. 192
Light Meter Inst. 192
.....
(Signed)

CITY APPROVAL NUMBER

Light .....
Power .....

Remarks:

Name COLLIER ,MR. C.A.
Location 48 PARK LANE
ATLANTA Ga. Date 11-23-20 192
Class of Service
STRAIGHT GAS ELEC. LIGHT
P////////// E//////////
NEW BUSINESS
Trans. from
TO BEGIN AT. ONCE
NEW WIRING REMARKS
O//////
NEW CUT-IN RES.
//////////
RUN GAS SERVICE.

TK
Nº 8445

System A.C. Phase
CONNECTED LOAD
40 - 50 Watt Eq.
H. P
LEDGER ENTR'D
By
FOLIO CHK'D
By

FIG. 2—MASTER COPY OF ORDER PRINTED IN HECTOGRAPH INK

although the number of customers has been increased in the intervening period by 7,800, or 15 per cent. The number of orders during this same period have increased 16 per cent. In addition the new form has eliminated a great deal of lost motion and lost time—just how much it is impossible to estimate with accuracy,

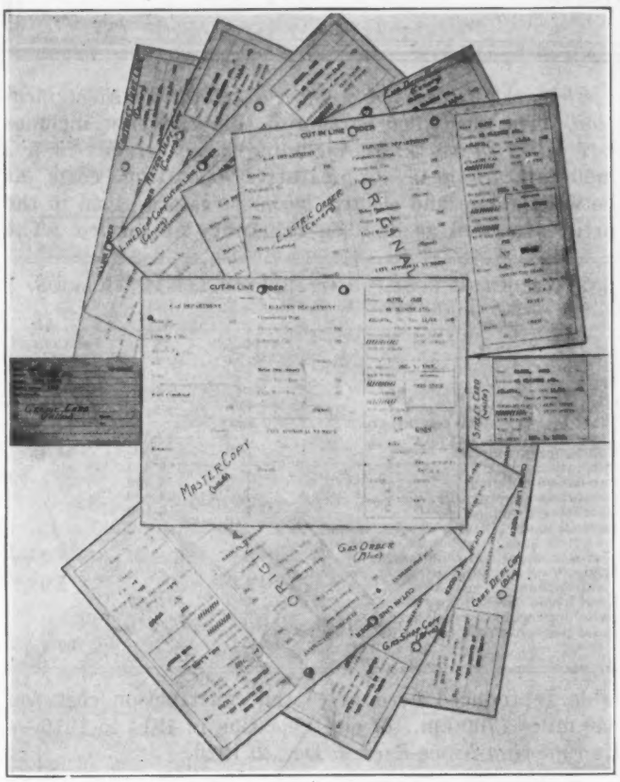


FIG. 4—COMPLETE SET OF COMBINATION GAS AND ELECTRIC ORDER SHEETS TAKEN FROM MASTER COPY

but more than was at first anticipated. In the other departments, besides speeding up their work, it has removed a fruitful source of friction between them and the contract order department caused by illegibility and errors in transcribing. Last, but not by any means least, it has given to the prospective customer a more businesslike impression of the company than he could possibly have obtained under the old form of accepting customers' applications.

Advertising Essential to Successful Merchandising

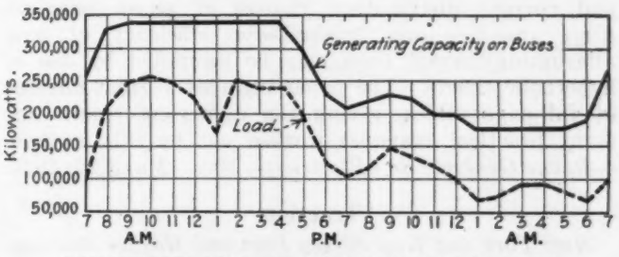
THAT one of the most essential factors in good merchandising practice is advertising was brought out in an investigation conducted by the merchandising committee of the Southeastern Section of the N. E. L. A. However, it found that very little effective advertising is being done, and that while a considerable sum of money is spent annually for this purpose, it is not being spent wisely and as a consequence results have not been all that could be desired. Some companies prefer local advertising, while others use almost every variety offered. Use of the show windows and local newspaper advertising were favored as being most desirable and productive of results.

An important factor which is overlooked by many companies is co-operation with electric sign manufacturers, who are always willing to furnish sketches and designs and will also send representatives to assist in selling the signs. In the opinion of the committee companies should carry on active sign campaigns, not only for the revenue derived from their sale and the consumption of energy but also with a view to improving the night appearance of city streets.

Summarizing the status of advertising as carried on by central stations, the report of the committee said: "Our investigations prove that, as a whole, our show windows and store interiors are not up to the standard of some of our competitors. This is a deplorable fact, as it is through these two mediums that we make the greatest appeal to the prospective purchaser. Our stores and show windows should be, without a doubt, the best lighted and most attractive in our locality. It is absolutely essential that we keep up with competition in advertising and that our stores should look their best at all times. The most essential points in producing interesting and profitable advertising may be enumerated as follows: (1) Originality, (2) artistic design, (3) consistency, (4) truthfulness."

Load Curve Shows Advantages of Interconnection

EIGHT of the principal electric service systems in New England are now interconnected, and the operating advantages of this arrangement are widely recognized. The accompanying diagram represents the combined twenty-four-hour load curve of these systems for Wednesday, June 16, 1920. The peak load of the period was 255,000 kw., occurring at 10 a.m., the evening peak, at 9 p.m., being 150,000 kw. The total generating capacity on the combined buses of these systems was 340,000 kw. at the peak and 230,000 kw. at 9 p.m. In the cases of four of the systems the reserve capacity on the buses during the forenoon peak was a smaller percentage of the local load than was the case with the combined system, and at the evening peak five systems had a smaller reserve capacity ratio than the combined systems. That is, interconnection enabled several of the companies to get along safely with less equipment on the bus than would have been feasible without the tie-in. The Edison Electric Illuminating Company of Boston, New England Power Company, Narragansett Electric Lighting Company of Providence, R. I., Turners Falls Power & Electric Company, Eastern Massachusetts



CONSOLIDATED LOAD AND CAPACITY CURVE OF EIGHT INTERCONNECTED SYSTEMS

Electric Company, Eastern Connecticut Power Company, Fall River Electric Light Company and United Electric Light Company of Springfield were interconnected when the curve was prepared. In four forenoon and three evening cases the reserve capacity on the local buses was less than 30 per cent of the load. The combined reserves as shown by the curves were 36 and 53.3 per cent respectively of the combined loads at the time of the morning and evening peaks.

Digest of Electrical Literature

Including Brief Abstracts of and References to
Important Articles Appearing in the Scientific and Engineering Press
of the World

Generators, Motors and Transformers

Efficiency of High-Tension Transformers as Used for X-Ray Purposes.—REGINALD MORTON.—The author takes up the subject of a more efficient means of exciting X-ray tubes from the point of view of the physician and states that the essential need of the radiographer is a supply of X-rays having a high degree of actinism and with sufficient penetration to pass through the thickest parts of the body without serious loss of this actinism. A "soft" or low-resistance tube gives off very actinic rays which have only a low power of penetration. The penetration can be increased to a limited extent by raising the voltage of the current applied to the tube. The author then goes into a detailed discussion showing how these prime requirements may be met.—*Journal Institution Electrical Engineers*, London, August, 1920.

Generation, Transmission and Distribution

Electrical Development in Shanghai.—I. V. ROBINSON.—Some idea of the rapid growth of electrical supply systems in Shanghai is given in the following table:

Year	Plant Capacity, Kw.	Maximum Load on Generators, Kw.	Output, Kw.-hr.
1915.....	19,600	14,400	50,014,128
1916.....	19,600	19,167	62,402,478
1917.....	29,600	20,927	78,796,232
1918.....	31,600	22,012	86,543,469
1919.....	38,600	28,368	102,622,803

Details of the Riverside station in Shanghai show that this is a modern steam turbo-generator plant.—*Beama* (London), January, 1921.

Determining Transmission Characteristics of Alternating-Current Lines by Hyperbolic Charts.—BLONDEL and LAVANCHY.—In a long article, which forms a continuation of an earlier paper by Blondel on the same subject, the authors show in great detail how voltage and current distribution, change of phase relations along the line and transmission efficiency of long alternating-current lines may be computed by use of hyperbolic charts. The paper includes a great number of full-page tables, giving the numerical results for many practical examples worked out by this method. —*Revue Générale de l'Electricité*, Nov. 13 and 27, 1920.

Traction

New York and New Jersey Port and Harbor Development Commission.—A system of belt lines to make direct rail connections to the greater part of the waterfront of New York Harbor and a plan for building an underground "automatic-electric" freight subway loop system for distribution on Manhattan Island are the principal features in a plan proposed in this report for the solution of the New York port problem. The plan also proposes belt-line links in New Jersey, Brooklyn, Queens, Staten Island and the Bronx.—Report of the Commission, Jan. 24, 1921.

Chicago, Milwaukee & St. Paul Railway Electrification.—The electrified portion of this road now includes 647 miles (1,040 km.), including heavy grades in five mountain ranges. Comparative operating costs as between steam and electric locomotives are given in the article, as well as data on reliability of service. The table reproduced here gives the construction cost for 440 miles (700 km.) of electrification in 1914 to 1916.—*Engineering News-Record*, Dec. 2, 1920.

CONSTRUCTION COST FOR 440 MILES OF ELECTRIFICATION, 1914–1916; C., M. & ST. P.

	Average Cost per Route Mile	Average Unit Costs	Per Cent of Total Costs, Exclusive of Locomotives
Trolley system, complete.....	$8,390	.....	47.7
Transmission system, complete.....	2,360	.....	13.3
Transmission line, per mile.....	.....	$2,835	....
Substations, complete.....	6,050	.....	34.4
Substations, each.....	.....	189,400	....
Substation buildings.....	.....	38,400	....
Substation apparatus.....	.....	144,900	....
Operators' dwellings.....	.....	6,100	....
Miscellaneous: Right-of-way, change to electric lines, storehouses, minor apparatus at shops and roundhouses.....	265	.....	1.7
Engineering and administration, except for substations.....	514	.....	2.0
Road locomotives, delivered.....	.....	122,500	....
Switching locomotives, delivered.....	.....	37,700	....
Total per route mile (exclusive of locomotives).....	17,579	.....	100.0

Installations, Systems and Appliances

Electric Welding.—The questions of what constitutes good judgment in the selection of arc-welding equipment and of the fundamentals of its efficient operation are considered in a symposium under four different discussions. The opening discussion, by A. A. Nims, deals with the salient points in the selection of welding equipment. C. J. Holslag discusses the voltage characteristics and fundamentals of alternating-current transformer-type welders. The operation of welding, with a very clear statement of the phenomena of the transition of metal from the electrode to the work, is treated by H. E. Dralle. He explains the chemical and physical changes which occur with the fusion process and describes the wide range of applications of arc welding. P. O. Noble discusses common sense in the selection and operation of arc-welding equipment, with notes on automatic welding.—*Journal Engineers' Club of Philadelphia*, January, 1921.

Slip Regulators Versus Notchbacks.—GORDON GAGE. —This paper covers primarily experience with a 1,500-hp., 35-deg.-rise wound-rotor induction motor connected by rope drive and spur gear reduction to eight sheet mills. From experience with both methods the author believes that the slip regulator has satisfactorily met all conditions; that it is more dependable, more simple, easier to adjust, and will limit the peaks more effectively than the notchback control. The operating costs and kilowatt-hour consumption are virtually the same for the two types.—*Association Iron and Steel Electrical Engineers*, December, 1920.

Emergency Ship's Lighting Set Rated at 25 Kw.—This set consists of a paraffin engine directly coupled to an electric generator and mounted on a cast-iron bedplate together with the fan and radiator and fuel tank. The engine, it is said, develops 50 hp. on paraffin and 60 hp. on petrol. The generator is capable of a maximum output of 30 kw.—London *Engineering*, Nov. 19, 1920.

Electrophysics and Magnetism

Calculation of the Amplification Constant of the Weagant Thermionic Vacuum Tube.—ALEXANDER MARCUS.—This tube has the control electrode on the outside and because of the presence of the glass wall amplification is not possible for constant grid potentials. By making some simplifying assumptions the author is able to develop a theoretical expression for the amplification constant which involves the dimensions of the tube and the resistivity of the glass wall. When this resistivity is either very high or very low the amplification is small. In the latter case it is shown to depend solely on the dimensions.—*Physical Review*, January, 1921.

Unilateral Conductivity of Tubes Having a Salt Electrode.—MASAMICHI KIMURA AND JUNICHIRO NAGAHATA.—Vacuum tubes having a salt electrode were found to have the property of rectifying high tension on the current, and the conditions of perfect rectification were examined. An explanation of the process of rectification is given in the article.—*Memoirs of the College of Science, Kyoto (Japan) Imperial University*, June, 1920.

Telegraphy, Telephony and Signals

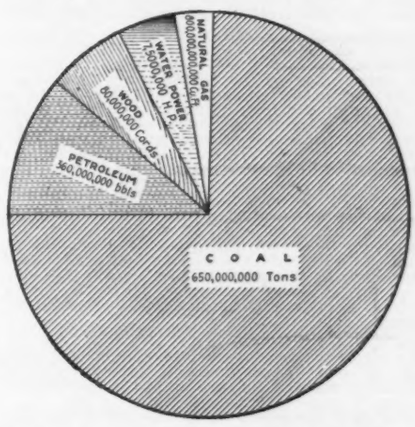
The Development of Thermionic Valves for Naval Uses.—B. S. GOSSLING.—The first four sections of this paper describe the introduction of valves into naval wireless-telegraph installations and the early work, experimental and theoretical, on the elucidation of their observed behavior. The article further deals with the principles of the numerical design of power valves, more particularly triodes, and with the rapid development in the manufacture of valves so designed. The investigation and improvement of small valves for use in reception, including both high-vacuum and gas-filled types, are briefly touched upon. Successive stages of approximation in the calculation of the characteristics of small valves with low operating voltages are illustrated, the final result of calculation indicating the degree of closeness with which the observed behavior of a high-vacuum valve can be accounted for in terms of known physical phenomena. The concluding section of the paper deals with the standardization of valves and their specification for quantity production.—*Journal Institution of Electrical Engineers*, London, August, 1920.

Impedance of Submarine Cables.—DOUGLAS C. GALL.—The writer finds that the measured impedance of the submarine cable differs in both magnitude and phase angle from the calculated value when such calculation is based upon cable constants of resistance and capacity measured by direct-current methods. This is shown by the change of phase angle with frequency. In general the angle is found to decrease with increasing frequency. Investigation into dielectric losses, the shielding effect of brass tape, armor and sea water and the effective increase in the resistance of the core resulting therefrom and its dependance upon potential current and frequency may permit of dealing with greater certainty with the behavior of new cables. But it is probable that variation in materials, complex secondary phenomena and reflection consequent upon the unavoidable jointing of different cable sizes of different constants would introduce ambiguous effects not amenable to exact calculation.—London *Electrician*, Dec. 24, 1920.

The Submarine's Wireless.—PHILIP R. COURSEY.—Heretofore it has been possible for the submarine to communicate by wireless only when riding on the surface of the water. In this case aërials would be erected on the deck. Recently, however, the development of the vacuum-tube amplifier has made it possible to receive messages from high-power stations and ships while the submarine is submerged. Data giving radius of communication for different conditions and showing that communication is not possible when the submarine is submerged to great depth are given in the article.—*Wireless World*, Nov. 27, 1920.

Miscellaneous

The Fuel Supply of the World.—L. P. BRECKENRIDGE.—Comprehensive data showing the world supply of fuel and the coal production in the principal countries having coal mines. An interesting chart shows the fuel consumption of the United States for one year. This chart is made up by the reduction of petroleum, wood and water power and natural gas to the coal equivalent of such fuel or energy. This chart shows what relatively small quantities of other fuels than coal are used in this country.—*Mechanical Engineering*, January, 1921.



ANNUAL CONSUMPTION OF FUELS IN THE UNITED STATES

Status of the Electric Steel Industry.—EDWIN F. CONE.—The statistics given show that the United States leads in output with 356 furnaces, a gain of 10 per cent in 1920. It is estimated that the number of electric furnaces in the steel industry in the entire world has reached 961.—*Iron Age*, Jan. 6, 1921.

ELECTRIC STEEL FURNACES IN THE UNITED STATES AND CANADA

Type	U. S., 1921	Canada, 1921	U. S. and Canada, 1921	U. S. and Canada, 1920	U. S. and Canada, 1919	U. S. and Canada, 1918	U. S. and Canada 1917
Heroult	159	18	177	170	163	146	84
Snyder and Von Schlegell	52	2	54	49	48	35	22
Rennerfelt	17	0	17	18	13	13	13
Greaves-Etchells	23	2	25	18	11	12	0
Gronwall-Dixon	11	1	12	13	13	12	9
Ludlum	13	0	13	12	11	6	5
Girod	5	0	5	5	5	5	4
Booth	14	0	14	12	11	4	0
Moore*	22	2	24	20	12	4	0
Induction	3	0	3	3	3	3	3
Webb	2	0	2	2	2	2	0
Stassano	1	0	1	1	1	1	1
Greene	18	0	18	11	8	1	1
Vom Baur	5	0	5	4	2	0	0
Wile	0	0	0	0	0	1	1
Detroit	1	0	1	1	0	0	0
Volta	2	8	8	0	0	0	0
Special*	8	10	20	24	27	24	12
Total	356	43	399	363	330	269	155

* Estimated.

Scientific and Industrial Research

(PRINTED IN THE THIRD ISSUE OF EACH MONTH)

A Department Devoted to Reports of Investigations Contemplated, or Completed, Research Facilities Available, and Suggestions for Co-operative Work.

Conducted by PROF. VLADIMIR KARAPETOFF
Cornell University, Ithaca, N. Y.

Research in Progress and Completed

[When investigations which have been completed are, in the opinion of the editors, of wide enough interest to the field we serve, details thereof will be presented in other parts of this paper. Contemplated research or that which appears to have limited appeal will be only briefly reported in this section, but details may be had by communicating with the investigator or institution named in the report. Readers are referred to the department "Digest of Electrical Literature" for investigations reported in other journals. The news and engineering sections should also be followed for research reported before technical societies.]

BATTERIES, AUTOMOBILE, STARTING AND LIGHTING, PERFORMANCE TESTS.

A brief study has been made of the performance characteristics of certain makes of batteries in several types of cars. Performance curves showing the instantaneous demand on the battery when cranking the engine have been obtained by the use of an oscillograph. The initial values of current and voltage which cannot be obtained by ordinary indicating instruments are shown at the time of closing the starter switch. An interpretation of the oscillograph records shows that much additional information might be obtained by this method concerning the operation of the starter system and of the engine itself, and indicates the possibility of applying the method to the study of problems relating to lubrication, ignition, compression and distributer action. In addition an exact method is obtained for measuring the speed from one revolution to another. Since the results which so far attained are more suggestive than quantitative no printed data are yet available.—*Bureau of Standards, Washington, D. C.*

CORONA, MEASUREMENT OF SHORT-TIME INTERVALS IN.

In an investigation of the time interval of the corona discharge a fine membrane and an oscillograph have been used to measure the time elapsed from the beginning of the corona current and the corona pressure. The time interval for characteristic pressure has been found to be of the order of one-third of one second. A manometric flame has also been used, and the pulsations in the pressure of the corona tube when excited by a 60-cycle alternating current have been made visible by means of a rotating mirror. It has also been found that the increase in pressure varies along the radius from the wire to the tube.—*Charles S. Fazel, Urbana, Ill.* (N. B.—This is a contribution to a study of transient corona. Such corona is now proposed for a relief of overpotentials.)

LAMPS, INCANDESCENT, SPEED OF FLASHING.

In a study of incandescent lamps for use in daylight signaling it has been found that a simple function involving only steady current measurements of wattage, resistance and temperature in the neighborhood of the maximum temperature of a flash, together with the thermal capacity of the filament, will serve quite accurately in rating various lamps as to their flashing speeds.—*A. G. Worthing, Nela Research Laboratory, Cleveland, Ohio.*

LIGHTING STREETS WITH TWO-LAMP UNITS.

An important development in street-lighting units is one which contains two lamps (in one type one of 1,000 cp. and one of 250 cp.), where by means of a relay in the casing of the fixture the 1,000-cp. lamp will be extinguished at midnight and the 250-cp. lamp lighted.—*A. I. E. E. Committee on Lighting and Illumination.*

RADIO, AIRPLANE LANDING SIGNALS.

At the request of the Air Mail Service of the Post Office Department the Bureau of Standards undertook to devise a method to enable an airplane to find its landing place in fog or in the dark. The method is a combination of radio and induction signals. By means of the radio direction finder the airplane steers its course to the general neighborhood of the landing field. The exact location of the landing field is then communicated to the airplane by magnetic induction from alternating current in a large coil on the landing field. The intensity of the signals falls off sharply, so that the position of the landing field is very accurately indicated to the airplane, beginning at about one kilometer from the coil.—*Radio Laboratory, Bureau of Standards, Washington, D. C.*

RECTIFIER, SILICON-CARBON CONTACT.

A four-element silicon-carbon rectifier as described by Hartsough (*Physical Review*, October, 1914) was applied to such alternating-current measurements as conductivity of electrolytes, coefficient of self-induction and coefficient of mutual induction. The rectifier in series with a D'Arsonval galvanometer takes the place of the telephone receiver or vibration galvanometer commonly used to indicate the alternating-current balance. With 2 volts to 6 volts at 60 cycles applied to the bridge arms, results have been obtained which are in good agreement with those derived by means of the older methods. Higher frequencies must be used with electrolytes to avoid polarization effects.—*J. C. Jensen, Nebraska Wesleyan University, University Place, Neb.*

ROTARY CONVERTER, FLASH SUPPRESSOR FOR.

Extensive tests have been made on a flash suppressor which is a high-speed switch actuated by the short-circuit current between the collector rings. This current reduces or kills the voltage on the commutator. The results of these tests have been reported in a recent number of the *A. I. E. E. Journal*, and they show that the flash suppressor will give ample protection from flashing as far as the alternating-current side of the converter is concerned. However, there are several problems connected with the application of the flash suppressor to synchronous converters, such as the increased duty on the collector rings, disturbance on the alternating-current supply system, and the machine falling out of step, which problems have not yet been worked out and which would form excellent subjects for research.—*Marvin W. Smith, Pittsburgh, Pa.*

SILK, DIELECTRIC CONSTANT OF.

When two dielectrics are electrified by contact and friction the one having the larger specific inductive capacity becomes positive. If this holds true with silk and other substances, then the dielectric constant of silk must be rather large. This suggested the measurement of this constant for silk. The usual condenser method was used. Since silk is not a continuous body several thicknesses were used, and from the weight of the silk, the total volume and the density of silk, the ratio of silk to air in this volume was determined and allowance made for the air spaces. The simple bridge method was used for the measurement of the capacity of the condenser having silk as a dielectric. The value of the dielectric constant in these experiments varied from 4.58 to 5.07.—*F. J. Rogers, Leland Stanford University, Cal.*

TELEPHONE SPEECH, ERRORS IN.

An extensive series of experiments on the source of errors in telephone communication indicates that the various sounds can be arranged quite definitely in the order of the number of errors for which they are responsible and that this order is dependent upon the reproduced volume of the sounds, so that certain letters are more often in error with a loud-talking receiver, and vice versa. The experiments also indicate that at average volume the errors due to the sounds *f* and *th* are greater than for all the other sounds together.—*Research Laboratories American Telephone & Telegraph Company and Western Electric Company, New York City.*

TONE GENERATOR.

A tone generator has been developed which produces sound by the use of a diaphragm in a magnetic field. The diaphragm is fastened between two pancake coils made up of annuli. A direct current is sent through the coils which are connected in opposition so as to develop a radial magnetic field in the diaphragm. An oscillating current from a vacuum-tube generator is sent through the diaphragm, setting up circular currents which react with the radial magnetic field to cause vibration of the diaphragm.—*C. W. Hewlett, Iowa City, Ia.* (N. B.—This is useful as tone standard in telephone and acoustic research.)

Suggestions for Research

CABLES, ALUMINUM STEEL-CORE, STRENGTH OF.

It is suggested that a determination be made of the strength of various sizes of stranded aluminum conductors with steel core, in order to establish the proportion in which the stress is divided between the aluminum and steel elements. Some engineers regard the steel core as carrying all the weight, while others seem to rely partly on the aluminum covering.—*D. W. Blakeslee, Pittsburgh, Pa.*

CONDUCTIVITY, THERMAL, OF SOLID DIELECTRICS.

It has been suggested that the thermal conductivity, k, of solid insulating materials is proportional to the product of the elasticity, E, and density, q, so that the ratio $(Eq)/k$ is constant for any material. This relationship is only roughly correct for optical glass (*Philosophical Magazine*, 1920, page 502), but the statement that the thermal conductivity increases with the density and with the elasticity seems to be approximately correct. Further research in this line is desired so as to determine a more definite relationship between the above-mentioned physical properties and thus to aid in finding better heat insulators and dielectrics of higher heat conductivity.—*Editorial Suggestion.* (N. B.—This is one of the problems in high-voltage alternators.)

INSULATORS.

Cracks occur in porcelain insulators usually in definite places—for example, near the metal cap. Would it be feasible to design an insulator which is split beforehand in such places, with the cracks filled with some insulating compound possessing flexibility?—*Editorial Suggestion.*

TEMPERATURE CONTROL, THEORY OF.

The development of temperature controllers for industrial processes is seriously handicapped by the lack of a theoretical treatment of the subject. Instruments for this purpose are at present capable of doing little more than closing one circuit when the temperature is high and another circuit when it is low. A mathematical treatment of the performance of a simple furnace under the action of various disturbances would be a material help in the practical work on temperature control.—*Leeds & Northrup Company, Philadelphia.*

TRANSFORMERS, INSTRUMENT TYPE, RATIO OF.

The development of a readily portable device for the determination of the ratio and phase angle of instrument transformers is needed. A device which would eliminate the necessity of delicate instruments would be advisable. Such a device would be valuable in checking the instrument transformers used on important loads without removing the transformers from service. H. S. Baker has developed a method for current transformers described in the *A.I.E.E. Proceedings* of September, 1918. A method for potential transformers is available, with modifications recommended by the Bureau of Standards, but there is no method embodied in a single instrument suitable for both current and potential transformers which is perfectly satisfactory for field use. Dr. Agnew of the Bureau of Standards has developed a method using watt-hour meters which may be applied to both current and potential transformers, but this method requires a standard transformer of the same ratio as the transformer under test and hence has serious limitations for the purpose indicated above.—*W. P. Dobson, Hydro-Electric Power Commission, Toronto, Ont.*

TURBO-GENERATOR UNITS, UNCOUPLING OF.

It is desired to develop a quick method of uncoupling the alternator from the turbine in turbo-generator units so that the generator may be used as a synchronous condenser to improve the power factor during such times as its output as a generator is not available.—*Prime Movers Committee, N. E. L. A.*

News of the Industry

Chronicle of Important Events and General Activities in the Technical, Commercial and Manufacturing Fields With Announcements and Reports of Association Meetings and Conventions

New Jersey Governor's Removal of Commission Is Upheld

BY A VOTE of seven to six the New Jersey Court of Errors and Appeals this week affirmed the Supreme Court's decision sustaining the judgment of ouster issued by Governor Edwards against the four members of the State Board of Public Utility Commissioners.

This action will leave the state without a board until the Senate either confirms a new board nominated by the Governor or the Legislature enacts a law creating a new commission. The lower house at once passed Senator Wadsworth's bill for a new board of three members at a salary of $12,000 a year each, the Governor to be without power of removal.

Final Water-Power Regulations Expected Before End of Month

THE remainder of the major regulations covering the administrative features of the water-power act, it is stated, will be promulgated before the end of February. The draft of these regulations was taken up for discussion last week by officials of the Federal Power Commission and representatives of outside interests. During the conference, which lasted two days, a great many changes were suggested. It became apparent early in the discussion that the views of the officials of the Federal Power Commission are greatly at variance with those of the representatives of the outside interests on some of the principal questions involved. Finally it became evident that no agreement could be reached immediately and it was decided to allow the matter to go over for a week, so that each interest might have an opportunity to revise its views in the hope that they could be brought more nearly into harmony.

The National Electric Light Association takes exception particularly to the draft of the regulation with regard to depreciation reserves and the establishment of a system of accounting. Objection was made to the provision requiring regular charges for depreciation of project property. The desirability of not making such charges until the project is well established was urged, since it would be helpful in tiding over the period of establishment and finding a market for the power.

The representatives of the N. E. L. A. questioned the advisability of adopting a system of accounting, suggesting that the commission should admit the type of accounting approved by the respective state commissions. Where such commissions have not been established it was suggested that the licensee be permitted to submit a system of accounting for the approval of the commission.

The question was taken up at the meeting of the commission on Feb. 14, and the commission approved the view of its chief accountant that regular depreciation reserves should be set up and maintained and that a uniform system of accounting should be established by the commission.

Switch Limitations and Cable Temperatures Features of A. I. E. E. Convention

CONSIDERABLE interest in oil circuit-breaker limitations was shown by the attendance of about 500 engineers at the opening meeting of the mid-winter convention of the American Institute of Electrical Engineers, held in New York this week. The convention was opened with an address from President Berresford. As announced in a previous issue of the ELECTRICAL WORLD, the papers of the evening were "Present-Day Practice Limitations of Oil Circuit Breakers," by H. R. Woodrow, and "High-Current Tests on High-Tension Circuit Breakers," by Philip Torchio. The paper by Mr. Torchio was particularly entertaining, being accompanied by motion pictures which showed the action of oil-switch parts when subjected to currents as high as 100,000 amp.

Thursday morning's session also attracted widespread interest. Six papers were presented expressing different ideas on maximum operating temperatures for paper-insulated cables. One of these is published quite fully in this issue, beginning on page 413. Features of the remaining papers and discussions at this convention will be published in next week's issue of the ELECTRICAL WORLD.

As usual, the dinner-dance at the Hotel Astor constituted the chief social function of the convention. On Friday evening Dr. M. I. Pupin was presented with the Edison medal for his contributions to electrical science. "Wave Transmission" was the subject of a lecture given by Dr. Pupin on this occasion.

Inspectors Working to Minimize Appliance Fire Hazards

A CAMPAIGN to minimize fire losses due to improper construction, installation and operation of electrical appliances is being developed by the Western Association of Electrical Inspectors. A circular to the electrical industry has been sent out in which a tentative list of the responsibilities of the manufacturer, the electrical contractor-dealer, the central station and the inspection bureau is presented for criticism and suggestion before use is made of the material contained therein.

The manufacturer's responsibility is viewed as the design of appliances to minimize the fire hazards, co-operation with the underwriters, furnishing of safety instruction with each appliance, and uniformity as far as possible in plugs, cords, general design and safety instructions. The contractor-dealer's responsibility is held to be for adequate wiring installations,

the handling of approved appliances only, educational work through architects and employees and consideration of public interest. Responsibility is placed on the central station for the education of the public through its employees in the proper installation and use of appliances and in co-operation with manufacturers, dealers and inspection bureaus. The central station, it is stated, should also use its facilities for the detection of unsafe devices and to promote the installation of adequate wiring. Responsibility for establishing uniform wiring and installation practices, adoption of proper municipal ordinances and periodic reinspection of installations lies with the inspection bureaus.

The advocacy of mains of No. 10 B. & S. gage wire or larger and of power circuits for appliances is suggested. A systematic publicity campaign, particularly just before the holiday season, should be carried on, and educational campaigns with the architect, with the contractor-dealer and with the central station are suggested.

It is intended after a thorough discussion to revise the circular and use it as a basis of action on the part of the association members to minimize appliance fire hazards. The circular has been sent out for discussion from the office of W. S. Boyd, the secretary, at 175 Jackson Boulevard, Chicago.

Two New Issues This Week Total $9,000,000

TWO new issues of electric light and power company securities totaling $9,000,000 were offered this week. One was of $8,000,000 Pennsylvania Power & Light Company first and refunding series A mortgage 7 per cent bonds, sold at a price to yield about 7.68 per cent. The proceeds of the sale of these bonds will be used to retire floating debt incurred for construction which has been completed and will also provide funds for additional construction.

The other issue was of $1,000,000 Idaho Power Company first lien and general mortgage series B 7 per cent gold bonds at a price yielding 7½ per cent. The funds from the sale of these bonds will be used for construction now under way, which includes additional capacity of 10,000 kw. and 115 miles of transmission lines.

Production and Distribution Problems Discussed by New York Association

THE problems of the small plant, the importance of close voltage regulation and several features of distribution were discussed at a meeting of the production and distribution sections of the Empire State Gas & Electric Association in Rochester, N. Y., Feb. 10 and 11. F. A. Dressler, Cortland County Traction Company, related the difficulties which are peculiar to the small plant. The necessity for close regulation of voltage in industrial plants was discussed and illustrated through examples by O. W. Bodler of the Eastman Kodak Company.

An interesting discussion on electrical department organization was entered by T. H. Yawger, Rochester Gas & Electric Corporation; A. C. Jordan, Elmira Water, Light & Railway Company; W. C. Blackwood, New York & Queens Electric Light & Power Company; H. W. Watt, Westchester Lighting Company, and W. C. Pearce, Syracuse Lighting Company. The advantages of aërial power cables were pointed out by F. A. Westbrook, Habirshaw Cable Company.

A demonstration of methods of locating defective insulators while in service was conducted by E. P. Peck, Utica Gas & Electric Company.

Other subjects discussed were reverse-power relays, preservative treatment of cross-arms, and policies regarding grounding and parallel operation of transformers, charges for service connections and control of long commercial circuits.

Portland Railway, Light & Power to Float Note Issue Through Employees

THE Portland (Ore.) Railway, Light & Power Company has placed on the market an issue of $1,000,000 in 8 per cent five-year gold notes dated March 1, 1921. These notes are the direct obligation of the company and will be issued in denominations of $100, $500 and $1,000, interest payable semi-annually. The notes will be callable on any interest date at a premium. An issue of $2,000,000 has been authorized, only $1,000,000 of which will be placed on the market at this time. The money will be expended during 1921 for improvements and betterments necessary to keep pace with the growth of the community. A feature of the sale is that it will be accomplished through the employees of the company instead of through bond houses as is customary. A special effort will be made to place as much of this paper in the hands of the company's customers as possible.

Further Development of Southern Company Hinges on Rate Increase

ERECTION by the Southern Power Company of an eight-million-dollar hydro-electric plant somewhere on the Catawba River, with Mountain Island as the probable site, is said to be contingent in large degree on the outcome of the company's rate case now pending before the Corporation Commission of North Carolina. This case is attracting much public attention owing to the attitude of the company, which has been a great factor in the industrial development of the state and the sister commonwealth of South Carolina. It is estimated that 4,500,000 cotton-mill spindles in mills scattered through the Carolinas get their power from the Southern Power system and that twenty-six cities and towns in North Carolina alone are lighted by energy developed by the system, while street cars in Charlotte and other cities derive their power from the same source.

All the energy that can be developed by the existing North Carolina plants of the company is, it is said, either in actual use or contracted for, and an additional supply of 30,000 hp. will soon be demanded. If it is not forthcoming from hydro-electric sources industrial companies will be forced to erect steam plants, with greatly increased production costs as the inevitable result.

Officials of the company are quoted as saying that once the rate matter is settled, there will be nothing to hinder the start of the projected new plant, which would have a capacity of 60,000 kw. and be completed in two years. Without an increase in rates enabling the company to pay the market price for capital officials doubt the possibility of going ahead.

Michigan Organizes Utility Information Committee

THE Michigan Committee on Public Utility Information has been organized with H. H. Tinkham, an experienced newspaper man of Ann Arbor, in active charge. The headquarters will be at Ann Arbor. With the organization of this committee there are such bodies actively at work in all four states in the Great Lakes Section National Electric Light Association.

A meeting of the officers and committee chairman of the Great Lakes Section was held in Chicago on Feb. 9, at which the formal organization of the section work was discussed and plans were made for future activities.

Atlanta Engineers Advocate Law to Regulate Practice

INDORSEMENT has been given by the Atlanta (Ga.) Chapter of the American Association of Engineers to a bill to regulate the practice of professional engineering, architecture and land surveying which it is intended to introduce into the Georgia State Legislature. This proposed law is said to follow closely one proposed by the Engineering Council. Copies have been sent to all members of national engineering societies in the state with the request that each society appoint two members to meet with the committee from the American Association of engineers and agree upon the terms of the bill. A joint committee will be functioning to this end within sixty days, and an effort will be made to have the measure supported in Georgia serve as a model for all the states. H. H. White, an Atlanta sales engineer, is chairman of the license law committee of the American Association of Engineers.

Recommends Tyler Plan for Great Falls Development

THE Federal Power Commission has sent a communication to the President of the Senate and to the Speaker of the House of Representatives recommending that the work on the development of power at Great Falls, on the Potomac River, be undertaken at once in accordance with the report made by Major Max Tyler, Corps of Engineers, U. S. A.

"Our study of the situation satisfies us," says the communication, "that all the power so developed will find a ready market in the District of Columbia and the circumjacent territory to which it can be transmitted without disproportionate line loss or distribution system cost.

"The plan for the development of hydro-electric power from the Potomac has three great advantages: (1) It contemplates a serial development of which the several elements can be separately and consecutively undertaken, with the result that the power resources of the District will be augmented from time to time as the capacity of the District for the absorption of the power developed increases; (2) the suggested conservation of use of existing steam installations for the production of power makes it highly improbable that any substantial loss will accrue to those who have invested in steam power plants, and (3) the serial development of water power will render unnecessary extensive and costly additional steam power plant installations, which would be necessary unless existing power producing facilities are supplemented, as here suggested, by the early development of a large body of primary power from a dam erected near Chain Bridge."

Standard Insulators May Be Used on 220,000-Volt Lines, Says Frank G. Baum

TRANSMISSION at 220,000 volts is now assured, according to a statement made this week to the ELECTRICAL WORLD by Frank G. Baum, who asserted that he had now the solution to the insulation problem. Mr. Baum, who is consulting hydro-electric engineer for the Pacific Gas & Electric Company and under whose supervision the design of the Pit River development is being carried out, is now in the East inspecting most of the equipment for this project, but particularly with the object of working out the 220-kv. insulator manufacturing details.

FRANK G. BAUM

With Prof. Harris J. Ryan of Leland Stanford Junior University he has been conducting experiments on insulators working under a pressure of 220,000 volts and over, and with proper shielding of a type recently worked out experimentally he has demonstrated that standard insulators can be used at these higher voltages.

"However, engineers would be making a mistake," Mr. Baum asserted, "to go to these higher voltages just because they are higher. The economics of engineering development must play the heaviest part.

"This thought goes even further. In the great hydro-electric development of the country that is coming engineers must not be encouraged to build the highest dams, the largest plants, lines of the highest voltage, just because they are record-breaking. Conservatism and good economics must rule. Furthermore, engineers ought to be honest and make honest estimates—not a million-dollar estimate where it is known the job ultimately will cost two millions. If the engineers do not act conservatively and honestly, there will once more be hydro-electric failures and loss of public confidence.

"In the Pit River development we are going to transmit energy at 220,000 volts, not because it is a record, but because it costs less. At the lower voltages the regulation was poorer and more circuits were needed. We expect to transmit 150,000 kva. per circuit, each circuit having a cross-section of 500,000 circ.mil."

Another important problem on which Mr. Baum is working in connection with this development is that of close regulation of long high-tension lines. He stated that he is planning to secure on the Pit River lines practically uniform voltage and operation. From the plant to the first substation is 200 miles, and from this station to the second substation is 260 miles.

Electrical Sales Associates Organized in New England

FOLLOWING the recent "get-together" meeting of electrical men at the Boston City Club, a formal organization has been established under the name "Electrical Sales Associates of New England," planned to work along co-operative lines, including the leading branches of the industry leagued together for the upbuilding of trade and advancement of mutual interests. William Gould, 77 Franklin Street, Boston, was elected chairman; M. R. Griffeth, 84 State Street, Boston, treasurer, and Frank J. Allen, 10 High Street, Boston, secretary. This action crystallizes the establishment of the New England electrical league into a permanent organization, the plan having been launched in a broad way at the meeting above mentioned. Annual dues have been set at $5 per member. The single purpose of the organization, Secretary Allen informs the ELECTRICAL WORLD, is the "100 per cent electrification of New England."

The work of the associates will be conducted largely through committees, whose activities will embrace monthly sales effort, advertising, data supply, conferences and adjustments, each committee representing the central station, jobber, manufacturer and contractor. Four members per committee have been appointed. The membership and work to be covered by each are as follows:

Monthly Sales Effort Committee.—Frank J. Allen, chairman; H. W. Porter, J. E. Livor and D. E. Robinson. The duties of this committee are to make recommendations to the four branches of the industry regarding monthly sales efforts, making the number of recommendations large enough to enable local central stations and contractors to make their choice as to appliances upon which to concentrate. Information will be given to manufacturers and jobbers, who will back up the central stations and contractors with advertisements and displays, together with demonstrators, if required.

Advertising Committee.—W. F. Abely, chairman; R. E. Holden, D. C. Gidley and Harry Cole. The committee will supply central stations and contractors with suggestions on the advertising for newspapers, showrooms and windows that will tie in with the article to be featured in each month's sales. It is believed that this will save a large amount of waste of advertising material and insure contractors and central-station men advertising helps as needed.

Data Committee.—Charles B. Burleigh, chairman; V. M. F. Tallman, George H. Wahn and George B. Quinby. Data will be furnished by this committee as to prospective business, service of appliances and resultant household and commercial economies, revenue and merchandising profit, suggestions for sales and accounting figures on successful sales elsewhere, the committee to consider itself a general information bureau. Figures will also be sought from contractors and central stations as to past year's sales, taking these as a basis upon which to strive to attain a minimum increase of 25 per cent in 1921. These figures are to be sent out by the data committee every three months.

Conference Committee.—Fred H. Smith, chairman; H. M. Savage, S. B. Condit and J. E. Wilson. This committee is to keep itself and the associates informed as to activities of other associations in the electrical industry and to make plans to have a representative attend meetings and bring about a better feeling between the four branches of the industry by citing profitable results obtained in communities where there has been practical co-operation.

Adjustment Committee.—A. J. Hixon, chairman; F. S. Hardy, F. L. Ball and W. S. Davis. This committee will take care of interbranch complaints and criticisms, suggesting means for removing difficulties and offering constructive advice.

The organization committee, whose work led to the formation of the permanent body, consisted of George H. Cox, chairman; C. W. Halstead, Almon Foster and J. P. Coghlin.

Private Initiative Not Discouraged in Superpower Program

THE relation of the superpower plan to the old program, the rate of replacement of old units with new, the incentives that may induce interconnection of existing systems, and above all the means of safeguarding public interest without discouraging private initiative, are, it was brought out at the meeting of the advisory board on Feb. 18 with John Barton Payne, Secretary of the Interior, the broad subjects into which the work of the advisory board of the Superpower Survey is divided. This was the third session of the advisory board devoted to the discussion of the corporate and financial structure necessary to put the engineering project into effect. It is the intention of the advisory board to draw up a plan complete in its legal and financial details and in its corporate and intercorporate relations. Dr. George Otis Smith, the Director of the United States Geological Survey, under whose direction the Superpower Survey is being conducted, comments as follows on the progress of the work:

"Less than two-thirds of the time allotted to the superpower investigation has passed, yet the engineering data have been received in such completeness that tentative conclusions on some of the phases of the problem already are apparent. I am confident that the engineering report will be submitted on June 30 ready for publication.

"While no preliminary report is planned in advance of the complete report, there is no desire to withhold from the engineering public any facts of interest so far as they are determined. As Mr. Murray has stated, some of the conclusions tentatively arrived at thus far in the investigation are the ratio of both operating and production costs in large and small power units, the measure of fuel saving possible in central-station operation and the relative operating economy of the electric as compared with the steam locomotive. He also has commented upon the density of traffic as the determining factor in the economics of railroad electrification, stating that approximately only 6,000 miles of the 36,000 miles in the region under study have at present a sufficient density to warrant electrification.

"Mr. Flood, the engineer-secretary of the Superpower staff, has cited statistics showing the growing demand for electric power in industry, the machine power per industrial worker in the United States having reached 3½ hp., and has estimated an increase in the total power load of manufacturing industry in the superpower zone during the next decade from the present figure of less than 12,500,000,000 kw.-hr. to 19,000,000,000 kw.-hr. Expressed in coal saving, had the Superpower system of interconnected central stations been in operation last

year the economies over the present system of isolated plants, central stations, small as well as large, and steam locomotives would have effected a saving of 30,000,000 tons of steam coal, and by 1930 the Superpower system should require annually 53,000,000 tons less than the continuation of the present system.

"An important part of the engineering report will be a chronological statement of the Superpower program, setting forth the location of stations and transmission lines in the order of their requirement to supplement existing units. In both its engineering and financial aspects the Superpower undertaking can well be pictured as like the erection of a great railroad bridge replacing a smaller structure inadequate to carry the ever-increasing load. The plans of the new structure must be complete to the last detail and on a scale that fully provides for the future, but they must be executed with scrupulous attention to the one essential requirement of the present—there must be no interruption to traffic. The Superpower plan will be a constructive program with no destruction of present values nor tearing down before building up.

"Not less important than these engineering results already attained is the progress being made in the study of the economic, financial, social and legal phases of the Superpower system."

Supplementary Course on Public Utility Regulation for Yale Law School

NATHANIEL T. GUERNSEY, head of the law department of the American Telephone & Telegraph Company, New York, has accepted the invitation of the Yale University School of Law to deliver a series of lectures upon "Public Utility Regulation" at the school, supplementing the existing courses in public utilities legal affairs. From five to ten lectures will probably be given, and it is expected that by this means the student will gain the benefit of much broad practical experience in a field where there is a decided lack of properly trained lawyers. In commenting upon the announcement to a representative of the ELECTRICAL WORLD, Dean Swan emphasized the importance of adequate functioning on the part of public utilities in view of their great investment and essential relations to the nation's political, commercial and social machinery.

"The regulation of these utilities," he said, "has hardly passed beyond the experimental stage, and to be permanent it must be based upon a proper balancing of the interests of the portion of the public using the service and that portion which has made the investment necessary to it. In this work the coming generation of lawyers must play a very important part."

Candidates for Presidency of A. I. E. E.

WILLIAM MC CLELLAN

C. S. RUFFNER

DR. WILLIAM McCLELLAN is a consulting engineer with headquarters at Philadelphia, Pa. For the past two years he held the position of vice-president of the Cleveland (Ohio) Electric Illuminating Company. Previous to that he was for three years dean of the Wharton School of Finance and Commerce of the University of Pennsylvania and a member of the firm of McClellan & Campion, consulting engineers with offices in New York and Philadelphia. Dr. McClellan was graduated from the University of Pennsylvania in 1900 and in 1903 received the degree of Pd.D. For a time he was engineer in charge of construction of the Philadelphia Rapid Transit Company. In 1905 he was made supervising engineer for Westinghouse, Church, Kerr & Company on the Erie Railroad electrification and in 1907 became a member of the firm of McClellan & Campion. In 1911 he was appointed electrical engineer and chief of the division of light, heat and power of the New York Public Service Commission, Second District. In 1914 he was retained by the First District in the valuation of the New York Telephone Company's property, and he has served other large utility companies on rate matters and executive problems. Dr. McClellan joined the A. I. E. E. in 1902 and was elected a fellow in 1912. He has served as manager and vice-president and as chairman of important committees. He has fostered the idea of co-ordinating the work of engineering societies on national problems.

C. S. RUFFNER is vice-president and director of the North American Company with headquarters in New York City. Before coming to New York in 1918 Mr. Ruffner was vice-president and general manager of the Union Electric Light & Power Company of St. Louis, Mo., and president of the American Light & Power Company, St. Charles, Mo., the Commercial Telephone Company and the Arrow Engineering Company, all of which are North American subsidiaries. Mr. Ruffner was born in Chicago in 1880. In 1900 he was graduated from the University of Missouri with the degree of bachelor of science in electrical engineering. He started in engineering with the Telluride Power Company and Central Colorado Power Company and has enjoyed an unusual experience in large power transmission work. Since 1911 he has been associated in an executive-engineering capacity with subsidiaries of the North American Company. To Mr. Ruffner is due the credit for the design and erection of the 60,000-kw. substation at the St. Louis end of the 110,000-volt transmission line from the Keokuk hydro-electric development. In 1916 Mr. Ruffner was appointed an associate member of the Naval Consulting Board. He joined the A. I. E. E. in 1902 and was elected a fellow in 1912. He has served as manager of the Institute and vice-president and has been appointed chairman of the committee on economics of electric service and other technical committees.

Nomination ballots must reach secretary A. I. E. E., 33 West Thirty-ninth Street, New York, before March 1.

Details of the Southern California Edison's Six-Year Expansion Program

DECLARING that public convenience and necessity require the construction of certain reservoirs, conduits and power plants on the San Joaquin River and its tributary, Big Creek, in Fresno County, the California Railroad Commission has issued to the Southern California Edison Company a certificate under which it may proceed with its construction program calling for the expenditure of approximately $48,000,000 in the next six years. The completion of this work will add to the hydro-electric generating system of the company a capacity of 316,000 kw. and an annual output of 1,500,000,000 kw.-hr.

The principal items of construction included in the proposed development are as follows: (1) Florence Lake Reservoir of 43,000 acre-feet capacity, at the headwaters of San Joaquin River; (2) tunnel, 11 miles in length, connecting Florence Lake with Huntington Lake; (3) conduit from Huntington Lake to Shaver Lake; (4) a new hydro-electric generating station known as power house No. 1-a, above Shaver Lake; (5) Shaver Lake Reservoir of 138,000 acre-feet capacity on Stevenson Creek; (6) conduit from Shaver Lake Reservoir to a generating station to be known as power house No. 2-a; (7) a new hydro-electric generating station to be known as power house No. 2-a on Big Creek; (8) a third generating unit in present power house No. 1 on Big Creek; (9) enlargement of hydro-electric generating station known as power house No. 8.

To Unify Insulated-Wire Specifications

A CONFERENCE on the standardization of insulated wires and cables was held in New York Feb. 2 at the call of the American Engineering Standards Committee and was attended by representatives of fourteen national organizations. After a thorough discussion it was unanimously decided that "the unification of specifications for wires and cables for other than telephone and telegraph use should be undertaken under one general plan, covering substantially all the more important uses." It was agreed that work on the following subjects should be included: Conductors—quality, stranding, sizes; rubber insulation, varnished-cloth insulation, impregnated-paper insulation, magnet wire, including enamel, cotton, and silk insulation; fibrous coverings, including asbestos; sheaths, armor, and standard make-ups.

Nearly a dozen organizations now have important publications on the subject, and it was agreed that the proposed work should be a unification of the specifications and standards already in existence, rather than an attempt to formulate entirely new standards except in fields not already covered.

It was the consensus of opinion that, in order to promote export trade, it would be desirable to have all the American wire and cable standards assembled in a single book. This form of publication, while giving due credit to the participating organizations, would appear to foreign wire and cable purchasers as a complete book of American standards rather than as the standards of societies comparatively unknown abroad. This has been done in a very thorough way by the Germans and to a considerable extent by the British, thus placing Americans at a decided disadvantage in foreign trade. It was agreed that if such a book were prepared and given proper publicity in foreign countries, it would remove one of the greatest difficulties under which American manufacturers are now laboring in developing export trade.

The proposed work will be carried out under the Engineering Standards Committee.

Wisconsin Association Will Discuss Rate Factors

THE thirteenth annual convention of the Wisconsin Electrical Association will be held at the Hotel Pfister in Milwaukee on Wednesday and Thursday, March 23 and 24. An inspection trip to the Lakeside plant of the Milwaukee Electric Railway & Light Company is arranged for March 23, a special train leaving Broadway and Mason Streets at 9 a.m. The plant is the new powdered fuel installation put into service in December last and is of especial interest because of the use of that form of fuel. The first convention session, which is a joint meeting with the Wisconsin Gas Association, takes place Wednesday afternoon. The following program will be presented on Wednesday afternoon and Thursday:

WEDNESDAY AFTERNOON, MARCH 23

"Safety," by Charles B. Scott, N. E. L. A. national safety committee; "Public Utility Associations," by P. V. Prather, secretary Great Lakes Geographical Division, N. E. L. A.; "The Work of the Wisconsin Public Utilities Bureau," by Frantz Herwig, director; reports of standing committees—Rural-line extension, G. C. Neff, chairman; steam-road crossing, F. W. Walker, chairman; street-railway and interurban, B. W. Arnold, chairman; legislative, Harold L. Geisse, chairman; safety code advisory, A. J. Goedjen, chairman.

THURSDAY, MARCH 24, 9:30 A.M.

"Induction regulators," by Frank Hershey, General Electric Company; "Electrical Merchandising," by C. E. Michel, sales manager Union Electric Light & Power Company, St. Louis; symposium on one-man-car operation, B. W. Arnold, H. A. Mullett, R. M. Howard, Dudley Montgomery and C. R. Phenicie; "Street-Railway Rate Schedules," by W. H. Sawyer of the American Electric Railway Association; "Power Factor—Methods of Correction, Measurement and Application to Rates," by F. A. Coffin, sales manager Milwaukee Electric Railway & Light Company; "Customer's Demand as a Factor in Rate Making," by L. B. Andrus, American Public Utilities Company.

A joint convention banquet will be held on Wednesday, March 23, at 7 p.m., when the toastmaster will be N. J. Whelan and the speaker Edgar A. Guest.

New Units for Pennsylvania Water & Power Await Lower Prices

UNTIL such time as advantage can be taken of lower general construction costs the Pennsylvania Water & Power Company, according to its annual report for 1920, will defer major additions to the equipment of its plant. This action is taken in spite of the fact that the market for hydro-electric power has been for some time greatly in excess of the amount of energy obtainable for the company's development on the Susquehanna. Foundations are in place for two additional units the output of which could readily be absorbed at the present time.

There are other construction improvements which have been studied out and planned in part during the past few years which will also serve to increase the output of the system.

L. W. Wallace Elected Federation Secretary

ANNOUNCEMENT was made at the meeting on Monday of this week at Syracuse, N. Y., of the executive committee of the American Engineering Council of the Federated American Engineering Societies that Lawrence Wilkinson Wallace, consulting industrial engineer of Baltimore, had been elected seretary of the council. At the same meeting Herbert Hoover, chairman of the federation, spoke of the council's plan to investigate waste in industry.

"The whole basis of national progress, of an increased standard of living, of better human relations, indeed, of the advancement of civilization," said Mr. Hoover, "depends upon continuous improvement in productivity. While we assume that great advances in living standards are brought about by new and basic invention, yet in fact even a greater field of increasing standards lies in the steady elimination of wastes. The primary duty of organized society is to enlarge the lives and increase the standards of living of all the people—not of any special class whatever. We are therefore proposing to make a preliminary examination of the volume of waste in certain industries, the proportion of fault that lies in each field."

L. W. WALLACE
Newly elected secretary of federation

The largest area of waste, according to Mr. Hoover, lies in the long periods of slack production and non-employment due to the ebb and flow of economic tides between booms and slumps. Another variety of intermittent employment, and thus great waste, lies in certain industries now operating upon an unnecessarily wide seasonal fluctuation, as, for instance, the bituminous coal industry. The second largest area of waste in productivity, the speaker stated, is the eternal labor friction, strikes and lockouts. He was of the opinion that the whole employment relationship will yet have to be reorganized to find its solution. Mr. Hoover sees great promise in this field during the past two years. Yet another variety of loss, it was stated, lies in the unnecessarily faulty distribution of labor supply due to seasonal and shifting demands. An adequate national employment service was suggested as the first need in bringing about reduction of these wastes.

Probably the next largest fraction of waste in productivity, Mr. Hoover pointed out, lies in a too high degree of individualism in certain basic products and tools. In other words, a standardization of certain national utensils makes for economy in distribution, in operation and in repairs. By this he did not mean that individuality should be stamped out of manufacture or invention or decoration; he meant that basic sizes should be given to common and every-day things. Another type of waste was said to lie in the failure to advance industrial equipment. The Superpower Board, it was declared, will demonstrate the saving of 25,000,000 tons to 50,000,000 tons of coal annually by the electrification of the Eastern power supply.

"Nor do we believe it is necessary," said Mr. Hoover in conclusion, "to effect these things by the government. The spirit of co-operation that has been growing in our country during the last thirty years has already solved many things; it has standardized some things and is ripe for initiative toward co-operation of a widespread character.

Mr. Wallace, the newly appointed secretary, was born in Austin, Tex., Aug. 5, 1881, and was graduated from the Agricultural and Mechanical College of Texas in 1903 in mechanical engineering, and from Purdue in 1912 he received the degree of M. E. The years 1903 to 1906 were spent in special apprenticeship with the Santa Fé Railroad. Then he joined the Purdue faculty, becoming head of the department of railway and industrial management. Since that time he has been engaged in research and consulting work in railway mechanical engineering and factory management. At one time he was assistant general manager in charge of production for the Diamond Chrome & Manufacturing Company, Indianapolis. Mr. Wallace is now serving his third term as president of the Society of Industrial Engineers. He is a past-president of the Indiana Engineering Society, a member of the International Railway Fuel Association, Western Railway Club, Master Car Builders' Association, Academy of Political and Social Science and Western Efficiency Society. He is vice-chairman of the federation's committee on the elimination of industrial waste.

Extensive Development Hangs on West Virginia Water-Power Legislation

THAT the West Penn Power Company will resume the development of Cheat River started by the Kuhn interests in 1916 but abandoned is vouched for by C. P. Billings, manager of the Wheeling Traction Company, a subsidiary of the West Penn Power Company, provided that the present restrictions upon the water-power development of West Virginia are removed by the State Legislature. A bill has been introduced in both branches of the Legislature which would amend materially the existing water-power statute in accordance with the recommendation of Governor Cornwell in his biennial message to the Legislature. This bill, it is believed, will, if passed, safeguard the interests of the public and of the state and at the same time yield a large revenue through royalties from water-power development. One of the important provisions of the measure pending before the Legislature, as pointed out by Mr. Billings, is that relating to the payment of large royalties to the state which will accrue in direct proportion to the amount of development. Another important provision of the pending bill is one that would require the operating company to meet the demands for electrical energy in West Virginia before any power generated from water could be transported from the state.

Authentic information is to the effect that the West Penn Power Company, in connection with its proposal to continue water-power development on Cheat River, will expend in the neighborhood of $15,000,000 for the construction of dams and power plants.

Alexanderson Urges International Service for Radio Engineers

E. F. W. ALEXANDERSON, chief engineer of the Radio Corporation of America and newly elected president of the Institute of Radio Engineers, in his inaugural message to the membership in New York City recently, called attention to the international scope of the institute and to the important service which it can render in the allotment of wave lengths to the various nations for international use. Unfortunately Mr. Alexanderson, who had been called to Europe, was unable to be present. His message was read by George Clark, who took advantage of the opportunity to pay tribute to the character of Mr. Alexanderson as a man and as an engineer.

The meeting was presided over by Fulton Cutting, president of Cutting & Washington, newly elected vice-president of the institute. Mr. Cutting also read a paper on "Some Considerations of Efficiency in Radio Engineering." He showed that radio transmission, although low in energy efficiency, might be highly effective. The low energy efficiency of the various elements, however, offers an attractive field for development. Dr. A. N. Goldsmith, entering upon another term as secretary of the institute, amplified the remarks of Mr. Cutting. John V. L. Hogan, retiring president, also spoke on this theme.

Director Smith Answers National Coal Association Superpower Slander

AS A RESULT of statements published by the *Coal Review*, the official publication of the National Coal Association, Dr. George Otis Smith, the director of the United States Geological Survey, felt called upon to explain to a Senate committee that there is nothing sinister about the Superpower Survey which is being made in the Boston-Washington area. One of the statements published by the *Coal Review* is as follows:

"The big electrical utilities of the East are preparing to invade the coal producers' market to the extent of 30,000,000 tons a year, through the so-called superpower project. This mammoth project is being forwarded under the guise of conserving coal."

After quoting this and other extracts from the article Dr. Smith told the committee, which is considering the advisability of imposing certain federal regulations upon the coal industry, that the *Coal Review* was right in saying the superpower survey is being conducted under the "guise" of conserving coal. "That is the actual purpose of the investigation," said Dr. Smith, "and it seems to me that when private business introduces the question of the motive of a government bureau simply because Congress authorized the receipt of certain money from certain people it is an extraordinary proposition. These people are contributing—I do not know in what amounts and I do not care. The people who are supporting the Superpower Survey are the railroads, which are to be the consumers of power if we have electrification of the railroads; the public utilities, which are producers of power, and the electrical machinery people. Every one of those interests is parallel and is going in the same direction as the public's interest. If the public utilities can get power cheaper the state regulations provide that they must sell it cheaper.

"There is nothing that would be a greater calamity to this country than for the government to operate any business even one-half the size of the bituminous-coal industry. It is my unqualified opinion that government operation would be a disaster because it would increase the cost of coal. It would make for a very high cost, and the public would have to meet it both as consumers and as taxpayers. There should be some control of the industry. That regulation is absolutely necessary unless we are going to be controlled by the industry itself."

Hydraulic and Steam Relay Topics Presented to Boston Engineers

ABOUT 400 engineers met at the Boston City Club on Feb. 7 to listen to addresses by W. M. White, hydraulic engineer Allis-Chalmers Manufacturing Company, Milwaukee, and E. B. Powell, consulting engineer with Stone & Webster, Inc. Their respective subjects were "Recent Waterwheel Developments and Settings" and "The Design of the Steam Power Station for Hydraulic Relay." Members and guests of the Boston Sections of the A. I. E. E. and the A. S. M. E. and of the Boston Society of Civil Engineers participated in a banquet which closed the series of joint meetings held within the last few months by the three organizations. Emphasis was laid by the speakers upon the attainment of efficiency in the utilization of interconnected plants, recent improvements in settings and economic analyses of relay-plant design to fit classified conditions. Prof. C. M. Allen of the Worcester (Mass.) Polytechnic Institute and R. J. S. Pigott of the Crosby Steam Gauge & Valve Company, Boston, also spoke briefly upon plant efficiency. Elmer Smith, General Electric Company, Boston, chairman of the Boston Section, A. S. M. E., presided.

Importance of Utility Credit in Relieving Housing Shortage

PUBLIC utilities will require $852,500,000 to equip properly the 1,250,000 houses and apartments which this country now needs, Philip H. Gadsden, vice-president of the United Gas Improvement Company of Philadelphia, declared last week before the housing conference of the Chamber of Commerce of the United States.

"This is an astounding total to contemplate," said Mr. Gadsden, "even in a field of industry which has good credit. Unfortunately, the public utilities field is not blessed today with good credit, hence this problem becomes doubly difficult for the operators who must furnish public service to the people when these houses finally are built.

"There is no hope on earth of ever getting these needed extensions if the credit of public utilities is not restored. The shortest step toward restoration of credit is for regulatory bodies to permit public utilities to earn such a return on their investments as will attract new capital into the public utility securities field. Regulatory bodies must recognize the fact that many public utilities were carried to the brink of disaster by enormous costs during the war and that investment in their securities practically closed because of uncertainty of returns. If these facts are not recognized and rates regulated accordingly, needed extensions cannot be made.

Current News and Notes

Timely items on electrical happenings throughout the world, together with brief notes of general interest.

Central-Station Service for Munson Steamship Building.—A twenty-five-story office building is being erected on Wall Street, New York City, by the Munson Steamship Company, which operates a passenger service to South American ports. It was at first proposed to install a private electric plant, but careful estimates showed that about 25 per cent of the $55,500 a year that such a plant would have required for operating expenses could be saved by contracting with the New York Edison Company, without taking into consideration the large area of basement space thus released for other purposes.

Wireless in the Jungle.—The British government is now planning an all-British chain of wireless stations from Cape Town to Oxford, England. The chain will include the powerful station built by the Germans at Windhuk, Southwest Africa, which is reported to have sent messages directly to Berlin, a distance of more than 4,000 miles. A new station is to be erected at Nairobi, British East Africa, to receive the Windhuk messages. From there they will be relayed to Cairo and thence to Europe. The present transmission route, says the *Wireless Age*, includes a station at Kikondji, in the heart of the Belgian Congo and so remote from civilization that one wireless operator fell a victim to a hungry lion.

Human Curiosity and "Safety First."—The official publication of the Travelers' Insurance Company of Hartford, Conn., bears rather astonishing testimony to the predominance of curiosity over prudence as an actuating motive with human beings when it says: "We have directed attention to the hazard from fallen and dangling wires many times. There is a record of a case in which twenty-two persons stopped at the sight of a fallen wire, and of this number seventeen stepped forth and touched it. From their actions we might reasonably infer that these persons all knew that the wire might be dangerous, but apparently curiosity had a more compelling influence than either intelligence or ignorance."

Electricity in Turkey.—Up to 1908 electricity, it is said, was scarcely known in Turkey, the Sultan Abdul Hamid refusing all concessions for its introduction except for lighting some of the streets of Constantinople. After the revolution of that year the tramways were bought up by a German combination, which obtained authority to construct many new lines, to run trains over the new bridge between Galata and Stamboul and to operate the system by electricity. It also was to supply all Constantinople with electric light and power. Another large industrial company, organized in Belgium with capital from a number of European countries, received many concessions before the war. All these projects are at present in a state of chaos awaiting the final adjustment of the Near Eastern political situation.

Electrocuting the Pine Bark Beetle.—One of the greatest enemies to forest growth in Oregon has been the bark beetle which infests the pine trees of the state. Quite recently an onslaught has been made on this insect by electricity with the aid of the California-Oregon Power Company, which serves a population vitally interested in the timber industry, and under the direction of Prof. W. J. Chamberlain of the Oregon Agricultural College at Corvallis, who had demonstrated in his

laboratory that the larvæ, pupæ and adults of the beetle could be readily killed by being placed upon the surface of wet blotting paper through which 110 volts was passed. Professor Chamberlain selected as the scene of operations in the field a location near the Keno power station where beetle-infested trees and the electricity necessary for the experiments were both at hand. A temporary 11,000-volt line was run off from the main Keno line on the south side of the river for a distance of 400 ft., and at a point about a half-mile from the Keno power house another short line was run from the Keno line on the north side of the river. A beetle-infested tree was selected and the bark chipped away down to the zone between the bark and wood, where the sap runs. Chains were then put around the tree and the wires attached to them. In some of the tests a single chain was used and the circuit made by grounding the other wire. The exact degree of success attained is not announced, but the experiments are to be resumed in the spring.

Associations and Societies

A complete Directory of Electrical Associations is printed in the first issue of each month.

American Electrochemical Society.—The spring meeting of this society will be held at the Hotel Chalfonte, Atlantic City, N. J., on April 21-23.

National Safety Council.—The Engineering Section of the National Safety Council will meet in Philadelphia on Monday, Feb. 28, conjointly with the Philadelphia Section, A. S. M. E. The principal subjects for consideration will be dust explosions, crane overhoist limit stop, signals and signaling in industry, and relation of boiler accessories to safety.

New British Engineering Society.—The Newcomer Society has been formed in Great Britain to encourage the study of the history of engineering and industrial technology. The founders of the new association maintain that this field has been neglected and that the world does not appreciate how much it owes to the professional engineers. Members will be sought in all parts of the British Empire and in foreign countries as well.

March Meetings of A. I. and S. E. E.—Meetings of the various sections of the Association of Iron and Steel Electrical Engineers are scheduled for next month as follows: Philadelphia, March 5, "Methods Used to Insure Continuity of Service," by E. D. Sibley, Metropolitan Edison Company. Cleveland, March 14, "Electric Propulsion of Ships," by W. E. Thau, Westinghouse Electric & Manufacturing Company. Birmingham, March 19, "Power-House Operation," by J. G. Somerville; "General Plant Spares," by J. E. Sayers, and "Test on the Bennett Surge Arrester," by W. W. Corcoran. Chicago, March 22, "Control Equipment for Auxiliary Motors," by J. D. Wright, General Electric Company. The Birmingham Section meeting announced for tonight (Feb. 19) has been changed to Feb. 23.

Coming Meetings of Electrical and Other Technical Societies

Association of Iron and Steel Electrical Engineers—Pittsburgh Section, Feb. 19; Chicago Section, Feb. 19; Birmingham Section, Feb. 23; Philadelphia Section, March 5; Cleveland Section, March 14.

American Physical Society—New York, Feb. 25 and 26.

Engineering Section, National Safety Council—Philadelphia, Feb. 28.

American Institute of Electrical Engineers—New York Section, March 11; Schenectady Section, March 18.

Associated Manufacturers of Electrical Supplies—New York, March 15.

Wisconsin Electrical Association—Milwaukee, March 23 and 24.

A. I. E. E. (New York Section) and A. S. M. E. (Metropolitan Section)—New York, March 25.

Recent Court Decisions

Findings of higher courts in legal cases involving electric light, power and other public utility companies

Commission Rule on Discontinuance of Service for Non-Payment Sustained.—The California District Court of Appeal has determined, in Lane vs. Pacific Gas & Electric Company, that a rule of the Railroad Commission preventing companies from discontinuing service for non-payment of disputed bills for metered service, if consumer deposits the amount with the commission pending adjustment, applies to a bill for gas which a defective meter had failed to measure but which had been determined by test. The commission's rule, the court held, is not rendered void because of provisions of the public utilities act giving patrons of public utility companies a right of action for its illegal acts. (193 Pac. 589.)*

Lighting Company Not Estopped from Attacking Electric Rate by Accepting Gas Rate Named in Same Order.—Where customers of a company furnishing electricity and gas to the public file petition with the Public Service Commission for reduced electric rates, and the company files a petition for increased gas and electric rates, and the commission consolidates the hearings, making only one order, the company may accept the surcharge permitted temporarily on gas bills without surrendering its right to contest that part of the order granting the petition for a reduction in electric rates. This decision has been made by the Supreme Court of Indiana in a suit brought by the Valparaiso Lighting Company against the Public Service Commission of that state. (129 N. E. 13.)

Not Contributory Negligence to Fail to See Low Overhead Wire.—In Fagin vs. Benton Harbor-St. Joe Railway & Light Company the plaintiff recovered damages in the trial court for injuries received while passing under an improperly insulated electric wire at a summer park. This wire was alleged to have sagged to within five or six feet of the ground for several days. The Supreme Court of Michigan found that the questions of how far above the ground the wire was, whether the plaintiff deliberately seized it and whether the company had knowledge or should have had knowledge of its dangerous condition, all of which were disputed, were properly submitted to the jury for decision. The court explicitly refused to say that the plaintiff was guilty of contributory negligence merely because he failed to observe the wire, although it was broad daylight, holding that since pedestrians are infrequently interfered with by overhead objects they cannot be expected to be on the watch for them. (180 N. W. 490.)

Where Evidence in Damage Suit Shows Death from Electricity High Voltage Need Not Be Proved.—The Indiana Appellate Court has affirmed a verdict for the plaintiff in Wilder vs. Ayrshire Coal Company, where damages were sought for the death of a car coupler who came into contact with an uninsulated transmission wire strung above the spot where he had to work. The complaint alleged that this wire carried from 2,200 volts to 2,700 volts, but the company sought to prove that the voltage was only from 240 to 260 and to attribute the fatality to some other cause. The court held that maintenance of an uninsulated wire in such a place constituted negligence and that it was not necessary for the plaintiff to prove the allegation as to the exact voltage, the fatality speaking for itself and the facts being properly submitted for the decision of the jury. (129 N. E. 260.)

Protection from Confiscation.—In a suit brought by the Dallas Telephone Company against the city of Dallas, Tex., to establish its right to put into effect increased charges during the time—held by the company to be unduly protracted—that the city took to determine a new rate schedule, the United States District Court held that the company had the right "to put into effect and to collect from its patrons the proposed rates and to deal with its patrons independent of the city's rate-making power and the same as any business concern, not government-controlled, deals with its customers." The court so held because convinced that the existing rates were confiscatory, that irreparable loss and injury would result to the company if continued, and that the city had refused or failed to determine proper charges.

Boy Injured by Inadequately Safeguarded Wires in Lot Used as Playground Entitled to Damages.—Although boys playing on a vacant lot owned by a central-station company were technically trespassers, the facts that the lot was inadequately fenced, that it contained a pit filled with water which obviously served as an attraction to boys and that employees of the electric company knew of the habit of the lads to congregate there rendered the company responsibile for injuries incurred by contact with its apparatus. Thus holding, the Court of Appeals of Kentucky refused to overrule a verdict for $3,000 awarded to the plaintiff in Lunsford vs. Union Light, Heat & Power Company of Covington. The injured boy in this case had chased a frog from the pit to the company's transformers, about 10 ft. away, and, one of the planks protecting these transformers having been permitted to fall down, his hand had come into contact with imperfectly insulated high-tension wires. (225 S. W. 741.)

*The left-hand numbers refer to the volume and the right-hand numbers to the page of the National Reporter System.

Commission Rulings

Important decisions of various state bodies involving or affecting electric light and power utilities

Good Service Must Precede Rate Increases.—Before granting the Sea Cliff & Glen Cove Gas Company an increase in its rates beyond the amount fixed in its municipal franchise the New York Public Service Commission, Second District, required the company to improve its practice and to render service more nearly approaching the adequate standard contemplated by law.

Effect of Application to Discontinue Service.—Authorizing an increase in steam-heating rates for the Southern Illinois Light & Power Company in the city of Hillsboro, the Illinois Public Utilities Commission asserted that a utility cannot complain upon being required to operate its plant without out-of-pocket loss where it has petitioned for authority to discontinue service, thus indicating its willingness to forego earning interest on capital invested.

Adjustment of Increase Granted Municipal Plants as Between Electricity and Water.—Finding that the increases of 40 per cent in electric rates and 28 per cent in water rates asked by the city of Shawano would throw a disproportionate burden on consumers of electricity, the Wisconsin Railroad Commission altered the proposed rates so as to produce the same revenue with a smaller rate of increase for electricity and a much greater one for water, it having been shown that on the basis of six months' revenue 29 per cent and 106 per cent increase for electricity and water respectively would be necessary to produce the required income. The commission held 6 per cent to be a reasonable annual return for a municipally owned plant.

Municipal Regulation of Interior Wiring.—Complaint against the rules of the Commonwealth Edison Company concerning interior wiring having been made to the Public Utilities Commission of Illinois, the commission refused to order any modification of them inasmuch as they were designed to comply with restrictions promulgated by the city of Chicago. "Without expressing any opinion as to the reasonableness of rules and regulations which the city of Chicago has promulgated or may promulgate," the commission said, "the commission believes it would be dangerous practice to remove restrictions governing the installation of interior wiring, as it has been found hazardous to life and property to furnish electric service where the interior wiring does not conform to the rules and regulations of best practice."

Men of the Industry

Changes in Personnel—Responsibilities and Association Appointments of Men Engaged in Professional, Executive, Operating and Commercial Branches of the Industry

H. B. Gear of the Commonwealth Edison Company, Chicago, a pioneer in the development of overhead central-station distribution practices, has been advanced from the position of engineer

H. B. GEAR

of distribution to be assistant to Vice-president L. A. Ferguson. Mr. Gear joined the staff of the Chicago Edison Company as inspector of interior wiring in 1895, after graduation from Cornell with the class of that year, and he has been with that organization ever since. In 1898 the problem of consolidating the circuits of five companies which had been taken over on the south side of Chicago was assigned to him. There were at least two competitors nearly everywhere in the territory, and they operated at various voltages and frequencies. He revised the system of secondary distribution, merged and unified the primary distribution, and by 1900, when what is said to have been the first three-phase, four-wire generating station was installed, he had cut the entire southern district of the city over to three-phase, four-wire, 60-cycle, 2,300/4,000-volts. In March, 1900, Mr. Gear was called back to the head office with the title of general inspector in charge of the interior wiring inspection, the testing and lamp renewal departments and the engineering of alternating-current distribution. In 1911 the department was reorganized, the engineering of underground distribution was added and his title was changed to that of engineer of distribution. Between 1900 and 1911 the 4,000-volt distributing system was extended to all other parts of Chicago outside the direct-current district, the work being done under the direction of Mr. Gear. General standards of feeder sizes were established and the demands and diversity of various types of customers were determined. The first published data on diversity factor were given by Mr. Gear in a paper presented in 1910 before the American Institute of Electrical Engineers and the Western Society of Engineers. For this paper the Western Society of Engineers awarded Mr. Gear the Chanute medal. In the same year Mr. Gear and P. F. Williams published as joint authors the first edition of their book, "Electric Central-Station Distribution Systems," which was later revised and enlarged. Mr. Gear edited the distribution section of the Standard Handbook in 1915. He is a fellow of the American Institute of Electrical Engineers and has been a member of the Institute code committee for about ten years. He has also been chairman of the overhead-line committee and the inductive-interference committee of the National Electric Light Association.

Major Carroll H. Shaw, until recently consulting engineer with the firm of Jackson & Moreland, Boston, and before that on the commercial engineering staff of the New England Power Company, has been appointed engineer of the newly created distribution and installation department of the New York Edison Company. Prior to his connection with the New England company he was in charge of the New England district of the power section of the War Industries Board. Before entering government service he held several responsible engineering and executive positions with central-station companies in the Middle West.

C. H. SHAW

S. G. Rhodes, assistant to the vice-president of the New York Edison Company and engineer in charge of the meter and test departments, has been appointed general superintendent of a newly created distribution and installation department. This has resulted from the expansion of the company's system and the corresponding need of closer co-operation between several hitherto unrelated departments. The new department will carry on the activities of transmission, distribution, service, maintenance, meter setting and inspection, filling the gap between the generating stations, substations and customers' service switches. In addition

S. G. RHODES

to his newly assumed duties Mr. Rhodes will maintain his position as assistant to the vice-president and as engineer in charge of meters and tests. Starting with the company in 1891 as wireman, Mr. Rhodes has risen through the positions of foreman of the arc-light department, superintendent of that department and engineer of the meter and test departments. For a number of years he has served on various technical committees of the N. E. L. A., the A. I. E. E. and the I. E. S. In addition he has conducted a considerable amount of original investigation for the New York Edison Company on illumination, particularly in connection with street and park lighting. He is a fellow of the A. I. E. E.

George E. Tebbetts, formerly with the construction and engineering division of Stone & Webster, Boston, has resigned to become associated with the Roberts & Schaeffer Company, engineers and contractors, Chicago.

H. P. Broughton, manager of the Interstate Public Service Company, Kentland, Ind., has resigned to accept a position with the Indiana Service Corporation, Fort Wayne, Ind. Mr. Broughton succeeds Charles B. Hart as superintendent of the light and power department of the Indiana Service Corporation. Mr. Broughton was at one time assistant to F. S. Hunting, general manager of the Fort Wayne plant of the General Electric Company.

W. J. Gilson, superintendent of the Northern Division of the Houghton County Electric Company, Houghton, Mich., has resigned to become associated with the Adirondack Light & Power Corporation, Glens Falls, N. Y.

C. B. Hutchinson, formerly district manager of the San Pedro district of the Southern California Edison Company, Los Angeles, has been appointed manager of the newly formed Fullerton district. Mr. Hutchinson is succeeded by P. S. Minner.

R. C. McFadden, who has been district manager of the Long Beach district of the Southern California Edison Company, Los Angeles, has been transferred to the position of district manager of Oxnard district, succeeding C. E. Houston, now manager at Redondo.

P. S. Minner, acting district manager of the Southern California Edison Company at Redlands, has been promoted to the position of district manager of the San Pedro district, succeeding C. B. Hutchinson, who has been made manager of the Fullerton district.

Charles Hackel, who has been appointed chief engineer of the Trenton & Mercer County Traction Company, Trenton, N. J., to handle matters pertaining to power plant and electrical operations, was formerly connected with the Western Electric Company.

C. G. Hanna, local superintendent of the Wabash Valley Electric Company, Sullivan, Ind., has accepted a position with the same company at Clinton, Ind. Mr. Hanna is succeeded by John T. Kester, formerly manager of the Noblesville (Ind.) Heat, Light & Power Company.

C. H. Shepherd, electrical engineer for the Commissioners of Lincoln Park, Chicago, has resigned to become associated with the Bemis Company, engineer-accountant, in the same city. After graduation from the University of Wisconsin in electrical engineering he became associated with the Allis-Chalmers Manufacturing Company, later becoming chief operator of the Fisk Street station of the Commonwealth Edison Company. He resigned that position to take up the duties of chief operator of the electrical department, Commissioners of Lincoln Park, later becoming operating engineer for this department. Mr. Shepherd was then appointed chief layout engineer for the Department of Gas and Electricity of Chicago, having supervision over the design, layout and construction of all equipment of the municipal street lighting system. In 1914 Mr. Shepherd resigned to become electrical engineer in charge of the electrical department for the Commissioners of Lincoln Park and rebuilt the Lincoln Park power and lighting system. He has done considerable consulting work on power and lighting systems for the last eight years and will continue in this capacity with the Bemis Company, which is taking over industrial valuation and appraisal work, as well as general engineering and public utility cases.

A. E. Hogrebe has been appointed sales engineer for the Baltimore territory of the Champion Engineering Company, Kenton, Ohio, manufacturer of electric traveling cranes.

Eugene F. Fagan, formerly general superintendent of the Federal Electric Company and its subsidiaries, Chicago, is now associated with the Lyon Metallic Manufacturing Company, Aurora, Ill., as purchasing agent.

H. D. Randall, who was recently appointed district manager of the Denver office of the General Electric Company, has been connected with the electrical business for the last eighteen years. Born in 1881, he prepared for college at Groton School and was graduated from Amherst in 1902. The same year he entered the service of the Westinghouse Lamp Company, remaining until Jan. 1, 1904, when he went to Pittsburgh with the Westinghouse Electric & Manufacturing Company. After a year there he went

H. D. RANDALL

to Seattle, and on Aug. 1, 1907, he took charge of the Spokane office of the Westinghouse company, remaining there for a year and a half. In December, 1908, he entered the employ of the Allis-Chalmers Company as salesman of hydro-electric apparatus, with headquarters in Salt Lake City. Four years later Mr. Randall joined the sales organization of the General Electric Company at Salt Lake City. On Dec. 1, 1914, he was called to Schenectady to the power and mining department, but the following year returned to the Salt Lake City office as local manager, holding this position until Nov. 1 of last year, when he was made district manager of the Denver office. Since March 1, 1919, Mr. Randall has been president of the Capital Electric Company and the Butte Electric Supply Company of Salt Lake City.

Frank Lynch, for thirty-three years associated with the Commonwealth Edison Company, Chicago, has retired, because of ill health, as chief engineer of the Northwest station of that company. Mr. Lynch will serve the company in a consulting capacity.

S. W. Dudley, chief engineer of the Westinghouse Air Brake Company, East Pittsburgh, Pa., has resigned to become professor of mechanical engineering in the Sheffield Scientific School of Yale University.

F. C. Reed has been transferred to the Charleston (W. Va.) office of the Westinghouse Electric & Manufacturing Company. Mr. Reed was formerly in the industrial sales department of that company at East Pittsburgh, Pa.

William S. Higbie, 114 Liberty Street, New York City, electrical engineer, formerly with the Chile Exploration Company, has established an inspection and purchasing service for buyers of power equipment.

H. F. Brinckerhoff of the Charleston (W. Va.) office of the Westinghouse Electric & Manufacturing Company has recently been appointed manager of the supply division of the Philadelphia district office. F. C. Reed succeeds Mr. Brinckerhoff in the Charleston office.

Roy S. Nelson, formerly engineer of the power station of the Ponce (P. R.) Electric Company, has been transferred to the Eastern Texas Electric Company, Port Arthur, Tex., to become assistant chief engineer of the Port Arthur power station.

A. F. Chamberlain, manager of the New York office of the Robbins & Myers Company, Springfield, Ohio, who has been devoting part of his time to the supervision of the Canadian plant of the company at Brantford, Ontario, will once more give his entire time to the New York office.

B. C. Holst has joined the sales force of W. N. Matthews & Brother, manufacturers of Matthews patented specialties at St. Louis. Previous to this connection he was advertising manager and manager of the specialty department of the Northwestern Electric Equipment Company at St. Paul, Minn.

E. C. Ryder, who has been president of the Bangor (Me.) Railway & Electric Company for the past five years, has resigned to devote his time to the practice of law. Mr. Ryder is a prominent Maine attorney and has been general counsel in that state for the Canadian Pacific Railway and the Eastern Trust & Banking Company. He was born in Readfield, Me., in 1854 and attended Colby University. Mr. Ryder has been closely associated with the growth and development of the Bangor Railway & Electric Company.

Robert Reynolds Robertson, who has recently joined the staff of the Society for Electrical Development, was formerly associated with the Winchester company's retail store department. In that position he selected sites for the Winchester stores and assisted in the work of hiring and training personnel for the retail departments. Because of his experience in this work and as buyer for the specialties department for the chain of Winchester stores he brings to the society a knowledge of buying, retailing, displaying and advertising merchandise.

Trade and Market Conditions

Business Reviews, Together with Market Letters from Important Trade Centers, on the Supply, Demand and Prevailing Prices of Electrical Apparatus and Supplies

Export Copper Financing Full of Meaning to Electrical Industry

OF UNUSUAL interest to the electrical industry was the floating this week of a $40,000,000 loan by the Copper Export Association. This loan is secured primarily by 400,000,000 lb. or substantially two-thirds of all unsold refined copper on a basis of 10 cents per pound of copper.

There are a number of angles to this transaction which electrical manufacturers would do well to recognize. First, the copper producers are now furnished with a credit substantial enough to withstand a protracted period of non-buying. Second, it will now be possible to grant credits to foreign purchasers on much more favorable terms than formerly and thereby open this market for American copper. Third, there is effectively removed from the market the dangerous element of a heavy surplus stock.

It is reasonable to believe, therefore, that copper is as low today as it will be for a great many months. Furthermore, it would not be surprising to see copper go to considerably higher levels in the near future. Thirteen cents is really too low for electrolytic and, if present indications count for anything, any manufacturer who buys on a 14-cent basis or lower would be making no mistake. Wire producers especially ought to be able to find in the present copper market sufficient argument to convince electric light and power companies of the advisability of ordering for future requirements on the current copper base.

Ten per Cent Reduction on Distribution Transformers

DISTRIBUTION transformers were reduced 10 per cent in price by two of the leading manufacturers, the reduction becoming effective on Feb. 12 in one case and on Feb. 14 in the other. Current demand, while less of course than a few months ago, continues in good volume. One of the manufacturers in question still has considerable back orders on hand, though these are being overcome. Deliveries in this instance average about ninety days on 100-kv. to 150-kv. sizes. In the other case production has just about caught up with current business, and though the present stock is small, it includes virtually all sizes, so that shipments can be made from stock. The delivery situation, it is expected, will continue to improve.

Rigid-Conduit Buying Merely for Individual Jobs

WITH the construction market progressing at a very slow rate, as far as new jobs are concerned, the demand for rigid conduit is quiet. Manufacturers are receiving orders here and there and are making shipments in quick time, but these orders are virtually only to cover the needs of individual jobs as they come up.

Jobbers show no tendency whatever to stock. The buying on their part is just to replace little breaks in their stocks as small orders creep in here and there. Manufacturers, on the other hand, are continuing their production to care for needs which it seems will require filling within, say, the next three months. These stocks are not what can be called large stocks, because it is thought that the demand will really not become insistent during the first half of the year. Any amount of building that may be started in the very near future could not get to the conduit stage much before early fall.

Manufacturers are willing to fill orders now when they know what their production costs are and ship the pipe to jobbers for stock. It seems, however, they can hardly be expected to accept orders on long delivery, which they could not now make up, at the price that shall rule in the future, which might be lower than present costs would warrant.

Prices have been holding rather steady since January reductions, although all producers are not quoting on the same card.

Lower Prices on Pole-Line Hardware

FOLLOWING price reductions of 5 to 15 per cent on pole-line hardware that went into effect during December and early January, as mentioned in last week's issue, prices have further declined. General reductions on the entire line, ranging from 5 to 7½ per cent, were put into effect by leading manufacturers on Feb. 15. It is hoped that this reduction will have some effect upon consumers in the way of inducing them to buy, as until the present time demand has been very light. With the closer approach of spring, however, manufacturers are hopeful that the program of extensions on the part of utilities will result in a better market.

In anticipation of this producers are continuing production so as to accumulate reserve stocks. These have been rather low in the past, but should now build up in good shape. Deliveries are considered entirely favorable, being from stock in most instances. In others shipment is not longer than ten days to two weeks.

Slightly Better Orders for Flexible Armored Conductor

IN THE last two weeks there has been a slightly better run of ordering in the flexible armored conductor market. It is not necessary that all producers shall be able to check up this condition, but it is true in some cases. There has been no general increase in business in this material, however.

Jobbers still have good stocks of armored conductor, and in some quarters slight overstocks are being lowered through an interchange among the trade. Of course, this makes for a condition of stock throughout the jobbing industry which is more nearly commensurate with the demand at this time. But it isn't keeping price cutting a negative quantity. In some sections this condition makes the market very unstable.

Manufacturers, as a rule, are producing armored conductor to take care of a good spring demand—a demand which should come to realization much ahead of that for rigid conduit because of the length of time necessary to bring the different classes of building construction to the wiring point. A fair amount of residence and stone construction and alteration would very soon deplete jobbing stocks of armored conductor, and the result would be an eager volume of orders for large lots on quick delivery. The condition that would follow would probably be little different from that which has existed in the past when trade stocks have run out at about the same time. A higher price might not be unexpected.

Jobbers can get this conductor now at a rather low price, and some manufacturers are of the opinion that they are passing up a good investment by continuing to hold off

buying in the face of a summer demand which all sections of the country look forward to with considerable optimism. The jobbers, according to manufacturers, are cutting prices and at the same time declaring that there is no profit in sales of flexible armored conductor at present prices.

Shipments of steel strip can be made in two to three weeks, and some lots are coming through on present orders, There is not a great deal of this material being produced for stock, though, according to some mills.

Report of German Producers Shows High Labor

THE three large establishments forming the German Siemens-Schuckert organization have just published their annual report (September, 1919, to September, 1920). While other German industrial enterprises were able to pay high dividends—some of them up to 30 per cent and more—the great electrical works had to be satisfied with smaller earnings. It is even astonishing that in spite of the immense increase in working expenses, the high state taxes, high-priced raw materials, steadily increasing freight rates, numerous strikes, etc., the companies were nevertheless able to distribute a dividend for the shareholders.

To what extent the expenditure for wages and salaries has increased is best illustrated by the following figures: For two of the companies—Siemens-Halske, Ltd., and Siemens-Schuckert—the wages and salaries paid in millions of marks were: 1913 to 14, 70; 1918 to 19, 236; 1919 to 20, 479; 1920 to 21, about 1,000. The report of Siemens-Halske, Ltd., states that wages and salaries are still increasing.

The net earnings of the three companies and the dividends paid were as follows: Siemens-Halske, Ltd., 16,433,-763 marks, of which 12 per cent was paid on the old capital of 63,000,000 marks and 6 per cent on the new capital of 63,000,000 marks. Siemens-Schuckert Company, 12,760,000 marks, 10 per cent; Schuckert Company, Nuremberg, 7,228,-542 marks, 9 per cent. The report of Siemens-Halske, Ltd., further states that in spite of the difficult economical conditions, the exports have considerably increased, which is chiefly because of the great international demand for all kinds of electrical goods.

During the year under consideration the capital of Siemens-Halske, Ltd., was doubled and a 4½ per cent loan of 60,000,000 marks has been raised in order to meet the financial requirements of the company. The report concludes by stating that sufficient orders are booked and that sufficient raw material is at hand.

Schedule Material Manufacturers See No Chance of Lower Prices

SOME of the large manufacturers of schedule material report that within the past two or three weeks there has been a slight improvement in buying in their field. This increase is said to come from large electrical contractors who are anticipating a revival of the building industry. Supply jobbers, it seems, remain almost entirely out of the market. The latter are apparently satisfied with their present stocks, which in the East, for instance, are too large. In that section jobbers are replenishing their stocks from other jobbers, and in this way supplies are gradually being reduced. It will probably be some time, however, before the widespread policy of keeping down inventories will allow of very heavy orders being placed with manufacturers. The latter, despite the prevailing quietness of the market, remain confident that the year will yet record good sales.

Prices of schedule material remain unchanged, and the view is frequently heard in the trade that these prices must come down before orders will be placed. On the other hand, several large producers emphatically state that there is no possibility of any price reduction. In their opinion, cutting prices would not stimulate buying one iota, and furthermore, conditions do not warrant lower prices, they say. In this connection it is pointed out that schedule-material prices were not inflated previously, that stocks of high-priced material are on hand, and that wage reductions of 10 per cent that have generally gone into effect did not bring anywhere near a corresponding reduction in cost. The present light demand is in itself a production expense, since the cost per unit mounts as mass production decreases.

Manufacturers' stocks are not large, although they are sufficient to insure prompt deliveries. At present production is on a curtailed basis.

Little Improvement Seen in Insulation Field

LITTLE increase has been noted in the buying of fabric insulation and compounds, etc., during the year up to date. Although it is stated that the number of orders which manufacturers are receiving is about normal, at the same time the amount of each order is still disappointingly small. A normal number of bills are sent out each month, but for small figures. Factory production is down pretty near the 50 per cent mark.

Cotton webbings are moving slowly, although recent price decreases of about 18 per cent have been applied. There is some distributer stocking of this class of insulation, as it is thought the bottom price has been reached. Compounds for finishing insulated wires are moving fairly well and have increased in February over January. Dry-battery filler also is feeling a fair response in the buying market. Shellacs and varnishes are going slowly.

Varnished silk has little call at present, and its price has held steady since the revisions reported in January. Varnished-cambric tape and cloth are about 10 per cent lower than last quotations made the latter part of January, and the demand is not well sustained. There is little manufacturing for stocks beyond what is deemed necessary to supply immediate future needs. That is, no future production on a large scale is being attempted even with a good outlook for summer business.

The Metal Market Situation

DOMESTIC demand for copper remains light, and though large brass and wire drawing interests were reported to have been feeling out the market recently, there is no increase in actual orders. The statistical position of producers, however, is undoubtedly stronger than it has been for some time. The removal of 400,000,000 lb. of surplus copper from the market is bound to have a salutary effect upon the situation, especially as production is being curtailed. Copper prices are no higher, but at least it seems that the bottom of the depressed market has been reached. Even the small producers are showing no willingness to shade the price of 13 cents delivered at which copper for prompt February and March shipment is held. One-quarter cent more is asked over the second quarter. In the outside market little business is done as prices are fully a quarter cent higher than producers'.

Demand for tin remains light, a downward fluctuation of ¾ cent per lb. being recorded during the week. The market for zinc is quiet. The manufacturer's basic price of sheets was reduced 1 cent to 11 cents the past week.

NEW YORK METAL MARKET PRICES

	—Feb. 7, 1921—	—Feb. 14, 1921—
Copper	£ s d	£ s d
London, standard spot	72 0 0	71 0 0
	Cents per Pound	Cents per Pound
Prime Lake	13.50	13.50
Electrolytic	13.00–13.25	13.00–13.25
Casting	12.67½	12.50
Wire base	15.75	15.75
Lead, trust price	4.75	4.75
Antimony	5.25	5.25
Nickel, ingot	43.00	43.00
Sheet zinc, f.o.b. smelter	11.50	11.00
Zinc, spot	5.50	5.37½
Tin	32.75	33.50
Aluminum, 98 to 99 per cent	28.00	28.00

OLD METALS

	Cents per Pound	Cents per Pound
Heavy copper and wire	11.00–11.25	11.00–11.25
Brass, heavy	6.00– 6.50	6.00– 6.50
Brass, light	4.00– 4.50	4.00– 4.50
Lead, heavy	4.00– 4.25	4.00– 4.12½
Zinc, old scrap	3.00– 3.25	3.00– 3.25

THE WEEK
IN TRADE

Prices When Quoted Are Those Prevailing at the Opening of Business on Monday of This Week for Points West of the Mississippi River and on Tuesday for All Eastern Points

A SLIGHTLY better tone can be noticed in this week's market, but as before, no high spots in buying in any sections of the trade have appeared. Price drops of 10 per cent announced last week, applied to apparatus, motors, etc., have had little effect upon buying, it is reported from all over the country. It may be too early to expect a reaction and none has appeared. Stocks in general are sufficient for immediate needs, and no tendency is noted among manufacturers to produce for stock very far in advance, consequently it is with difficulty that some plants are running in sufficient volume to keep their forces intact. In fact, shorter hours or lower rates of pay, or both, have become more noticeable in the past two weeks.

Wire is moving slowly, but a little better than in January. Wiring materials are quiet. A rather inactive insulation market shows the state of production in the apparatus and motor line. Collections are holding their own, but financial conditions as a whole appear to be on a slightly higher level.

NEW YORK

The ups and downs of trade among jobbers continue, but on the whole there has been no further retrogression of the market, while, on the other hand, each week several jobbing houses report a slight improvement in business. These same firms may next week report the gain only temporary, as is often the case, but the general continuing trend of the industry is undoubtedly toward better times.

Very little material is being ordered from manufacturers. Jobbers are keeping their inventories low and will not order goods for stock until actual sales warrant this, it seems. Maintenance of present stock accounts for the greater part of the orders that jobbers are placing, and this is mostly taken care of by the interchange of stocks among themselves. Much hope is placed upon a return of the building industry in improving the electrical trade, but from inquiries made among jobbers it seems that contractors are as yet taking very little interest in the market.

No price reductions by manufacturers are reported this week except on pole-line hardware, as noted elsewhere.

Conduit.—Half-inch black is holding close to $70 per 1,000 ft., with shading down to $66 in 2,500-ft. quantities, although one large jobber has consistently quoted slightly more than $79. Galvanized brings from $72 to $79. Demand is not large, with ample stocks on hand.

Flexible Armored Conductor.—Jobbers are buying their cable from one another and so have reduced overstocks. No. 14 two-wire, double-strip brings from $61 to $65 per 1,000 ft., although one or two houses have held to higher prices.

Rubber-Covered Wire.—Stocks seem to be reduced to fairly normal levels. Such demand as is felt is mostly in small quantities. Most jobbers are holding No. 14 at $8 to $8.75 in 10,000 ft. lots, though prices of $7.50 and $7.75 are also quoted by large houses this week.

Tape.—Stocks of both friction and rubber are adequate but not considered too large. Demand is quiet on the whole, though some jobbers are making fairly good sales. The latter state they will not order except to maintain stock, and this is being done by buying from other jobbers. In 100-lb. lots the selling price for standard grades of friction ranges from 48 to 50 cents per pound, and for rubber from 45 to 50 cents. There are variations of a few cents each way.

Lamp Cord.—No. 18 twisted in 500-ft. quantities ranges in price from $17.50 to $22 per 1,000 ft. Demand is poor.

Non-Metallic Flexible Conduit.—Little call exists at present and the size of stocks varies considerably. For 1,000 ft. of $\frac{3}{8}$ in. jobbers ask from $22 to $24.50, and for $\frac{1}{2}$ in. from $24 to $27 per 1,000 ft.

Heating Appliances.—Sales in this territory have fallen to very low proportions. Stocks of hollow ware in several instances are considered much too large and jobbers report that they will order sparingly if at all. A standard 6-lb. iron listing at $8 is this week being offered at $4.98 by a large department store, and another well-known make is being sold as low as $4.50 by some of the small dealers. Many jobbers state that appliance prices are too high to attract the public.

CHICAGO

A canvass of the various factors reveals a spotty situation in that manufacturers selling direct to users report additional activity while jobbers seem to be a unit in stating that the quiet of past weeks is unchanged. Price reductions are noted in many lines, but are so recent as to render impossible any reportable reaction. Manufacturers are continuing operations on schedules which are greatly reduced.

The jobbing trade is permitting stocks to run down. There is widespread demand on the part of buyers for guaranteed prices. Jobbers feel that, such being the case, and with probabilities apparently favoring declines in many items in the near future, it is not asking too much to look to the manufacturers to carry a portion of the risk.

No appreciable change is noted in the general situation in other commercial lines. Department stores are continuing to feature reduced price sales, and industrial plants are operating either on part time or with greatly reduced forces. The announced re-employment of 2,000 shopmen laid off by one of the railroads several weeks ago has helped to cause a feeling of optimism.

Power Apparatus.—Several standard lines of motors and generators are reported reduced in price 10 per cent. This cut was effective on Feb. 7, and the effect on the trade cannot yet be noted. Manufacturers selling direct to the user report increased inquiry and sales on sizes ranging from 1 hp. to 50 hp., although jobbers state that no change is apparent.

Power Control Apparatus.—Circuit breakers, oil switches, lightning arresters, rheostats and similar apparatus of standard make are reduced 10 per cent. Demand is very light, and stocks of most items are sufficient to fill any probable requirements.

Transformers.—Distribution transformers have also been cut 10 per cent. The gradual increase of a buying movement in the agricultural district promises an increase of business in this item. Power transformers are reported in ample supply with demand weak.

Construction Tools.—A cut is recorded on shovels, "spoons" and similar tools of about 10 per cent. Stocks in jobbers' hands are running low, and any steady buying would throw orders back on manufacturers for immediate shipment. Jobbers are not stocking.

Line Hardware.—No increase in business is noted and opinion is freely expressed that another cut is due, owing to reduced costs of raw materials.

Tape.—Prices hold firm to former levels, and stocks, particularly on rubber, are running low. For some reason this item seems neglected by jobbers to a certain extent, none reporting any definite policy in regard to stock maintenance. The feeling is that in view of possible price changes manufacturers should assume their full share of stock-carrying risk.

Heating Appliances.—Business remains quiet. Jobbers' stocks are not at all heavy, and dealers are also running low. Opinion is expressed that price adjustments in this line will be slower than in any other.

BOSTON

Although trade is unevenly distributed as to volume in New England a better tone pervades the market. A prominent Connecticut jobber reports 25 per cent better business than in January, and in Rhode Island improved conditions are noted. Boston jobbers are much affected by the building trades strike, but some good outside business is coming in. Collections are sharply watched, and buying for stock is very conservatively done. Increased buying by central stations is noted in some localities. Prices of motors, control equipment, distribution transformers and considerable other apparatus were reduced last week by about 10 per cent by a number of leading manufacturers. Manufacturers are generally running considerably below their capacity.

Meters.—Production has still to overtake the demand. Prices are steady and stocks scanty.

Lamps.—An excellent winter's business is reported, one distributer stating that the demand has fallen off only 10 per cent this month. Manufacturing for stock is proceeding to some extent. One factory added about 300,000 finished lamps to its stores in January and is running on two-thirds time, curtailing type "B" production about 25 per cent and type "C" about 33 per cent.

Motors.—Several leading makers announced price reductions around 10 per cent on motor and control equipment last week. Back orders are still occupying some factories. Local stocks are improving in range and qualtity and competition is keen.

Tape.—Among eight leading New England jobbers three had normal stocks of friction tape Monday, four were below normal and one reported excess. Those carrying subnormal stocks ranged from an existing supply for one week to two months' business. Ordinarily two or three months' supply is carried. Several are buying on a hand-to-mouth basis, and small quantities are being bought more frequently than a few weeks ago. The demand is rather light, but is well distributed among central stations, contractors and industrial buyers. Compound is in good supply with one exception. A tendency toward purchasing the cheaper grades of tape is evident. Prices vary considerably, a fair range being 45 to 57 cents on black friction tape, according to quantity, compound running from about 40 cents to 50 cents per pound. In the cotton insulating-tape market a better feeling is reported. Raw material and labor are easier, but no marked wage reduction has been made as yet in a leading establishment whose prices have fallen from 200 to 100 per cent above pre-war figures. Deliveries are excellent, but buying is cautious.

Flexible Armored Conduit—No. 14 double-strip was selling Monday in Boston at $65 per 1,000 ft., with light demand and good stocks.

Wire.—Unsteady prices featured the wire market at the opening of the week. No. 14 rubber-covered sold for $8 to $10 per 1,000 ft., dependent on quantity and local stocks. Weatherproof and bare bases were about 18 cents and from 16½ to 17 cents respectively. The demand is not so active as usual.

Non-Metallic Flexible Conduit.—This material was steady Monday at $22 per 1,000 ft. in the ⅜-in. size and $25 for the ½-in. diameter. No difficulty in getting this product is known. The market is quiet.

ATLANTA

A slow revival of business activities continues, and business men in general are assuming a more optimistic attitude of mind in reference to the future. Manufacturing plants continue to announce schedules for reopening, and the retail trade is reported on the increase throughout the section. The local electrical contractors seem to be kept comfortably busy with repair work and some new construction and report the receipt of a good number of inquiries for estimates on building to be undertaken in the spring. The Sixth Federal Reserve District reports that building permits in the twenty-one principal Southern cities for December numbered 1,688, valued at $2,922,921, a sharp decrease under December of 1919.

Ceiling Fans.—No movement in this line is reported, though a price reduction from $72 to $64 list has just been announced. Stocks have been accumulated in anticipation of the season opening on about April 1.

Wire.—Popular sizes of both weatherproof and rubber-covered continue to move in reduced volume, though inquiries for heavy purchases are being received. Stocks throughout the section are in excellent shape, with rubber-covered on a 16-cent base and weatherproof on a 17-cent base.

Tape.—The tape market, both friction and rubber, is reported rather dull, with jobbers placing orders only for immediate requirements. Most firms state that no heavy orders will be placed under ninety days as all firms have stocks on hand in all varieties sufficient for thirty to sixty days. Jobbers are expecting sharp price reductions similar to those in other specialties containing cotton and rubber. The present quotation on weatherproof is 48 cents per pound.

Schedule Material.—Heavy stocks have been accumulated, and all companies report sales very slow.

Porcelain.—As predicted last week, porcelain prices have been advanced approximately 20 per cent. Knobs and tubes continue to move quite satisfactorily, and stocks in general are reported fair, no acute shortage of material being in evidence.

Industrial Motors.—Manufacturers announce price reductions of approximately 10 per cent in all sizes. Stocks are in fair shape and the market is somewhat sluggish.

Distribution Transformers. — Municipalities and small utilities are taking quite a respectable volume of the more popular sizes. Local stocks are in fair condition, and prices are reported steady.

Farm-Lighting Outfits.—An increasing interest is reported in this line, accounted for probably by a slight price reduction on the part of the manufacturers to both the retailer and consumer. Stocks are somewhat low with shipments quite satisfactory.

ST. LOUIS

Business seems slowly but surely to be getting under way once more, each succeeding week showing a slight increase over the previous one. While the revival is not startling by any means it does indicate that the pendulum has started to swing the other way. Retailers report the appliance business picking up considerably, an increase in sales of vacuum cleaners being particularly noticeable.

St. Louis engineers are preparing plans for several small municipal light plants which will go through in the spring if the municipal bond market improves by that time. The dearth of actual construction continues. Inquiries from industrials are still heavy, with sales improving. The railroads and utilities pursue their policy of buying lightly, but many inquiries are received from them. The non-employment situation has bettered, several large industrials opening up again on part time, their labor costs having been adjusted in the meantime. Collections average sixty days.

Switches.—The Department of Electrical Inspection of St. Louis has announced that only switches of the safety type will be passed hereafter. This ruling is modified by the explanation that any switch inclosed in a metal box and indicating externally whether the circuit is open or closed will be considered a safety switch. Jobbers' stocks of knife switches are not large, while, on the other hand, their supplies of safety switches are heavy. Demand for the safety switch has been slow.

Tape.—Jobbers here stock only the ¾-in. black friction and rubber tape to any extent, carrying as a rule about 5,000 lb. of that size to 100 lb. of any other size. Stocks are ample to take care of demand, which is fairly steady. Jobbers have been following the practice of ordering new supplies about once a month in order to keep fresh stock coming in, but their orders for several months to come will be smaller than formerly. Both the black friction and the rubber tape, ¾-in., are being quoted at 45 cents per pound.

Motors.—Movement is slow, though there are still a good number of inquiries coming in. Stocks are getting heavy, but there have been no price cuts to date.

Knobs and Tubes.—Jobbers' supplies are topheavy, and there have been a number of instances of price slashing in order to cut down stocks. Quotations vary, but all of them are below replacement prices. Quotations on "Nail-it" knobs range from $22.80 to $30 per 1,000. Jobbers are asking $11.50 per 1,000 for ⅞-in. x 3-in. tubes. Despite the price cuts demand has not been heavy.

Fuses.—There is a steady demand for fuses, but present stocks are capable of taking care of it for some time to come.

Wire.—A good number of small orders continues to be the rule, with very little change of any kind in the market. Rubber-covered No. 14 is quoted at $8 per 1,000 ft. Several jobbers report good orders from contractors in outlying sections of Missouri.

Sockets.—Jobbers continue to report business very dull. Stocks have become unwieldy, but prices are being held firmly.

Poles.—Demand has increased in the last few weeks, but it is not heavy enough to be a serious drain on stocks. Prices are holding up, though the opinion is that decrease in cost of production will reach the buyer soon.

SAN FRANCISCO

There seem to be indications that California is recovering from the prevalent feeling of business depression. Still the 1920 crops, while big, are unmarketed in many sections because of the efforts of the growers' association to hold up prices. There still exists the spirit of hand-to-mouth buying.

These factors, however, are becoming neutralized by the steadily improving morale of the buying public, and many dealers are even reporting better sales for January of this year than for January of last year.

Switch Boxes.—A 20 per cent drop is reported in the price of standard switch boxes for non-metallic flexible conduit, a representative type now selling for 22½ cents each in lots of 100. Local stocks are big.

Insulating Materials.—Various decreases in price have occurred in cotton tapes and the like and sales are quite slow.

Cross-Arms.—Local stocks are excellent in the face of declining construction. As a gage of local prices it may be noted that the 3¼-in. x 4¼-in., 10-ft. arms, are selling f.o.b. Coast cities in fairly large lots at $1.22 each, and the same arm in the 5-ft. length at 61 cents.

Rubber-Covered Wire.—No. 14 single-braid solid wire has dropped slightly and is now selling in coil lots for about $9.40 per 1,000 ft. It is reported that many contractors are now placing fairly large assorted orders on the assumption that the copper market is at its bottom level.

Water Heaters.—Not very long ago many range installations were held up because of the shortage of electric water heaters, the biggest demand being for the 5-kw. size, generally with a thermostat. The decline of sales effort has remedied this condition and produced stagnant stocks. Jobbers, however, are not worrying over this item at least, for the abundant additional power promised for the near future will intensify sales effort by all branches of the industry.

SEATTLE—PORTLAND

In the Seattle and Portland districts very little change is noted in conditions over those obtaining during the last few weeks. Sales along most lines are light, but are showing gradual improvement, especially among materials utilized in building. Appliance sales in Seattle are considerably ahead of the mark usually made during January and February, and from present indications there will be considerable building, both residence and business, in Seattle and Portland this year. If this proves true, the lumber industry should be materially benefited. There is a gradual decline in prices, but these reductions are not materially affecting sales. Stocks are in fine shape, and no difficulty is experienced in getting shipments from the East.

Manufacturers in the Portland territory report business rather quiet, but the future continues to look bright. Collections are fair, though somewhat slow, but it is not felt that this indicates any ultimate difficulty in realizing the full indebtedness eventually. Jobbers state that business is improving somewhat since the first of the year. Collections by jobbers are still poor; in fact, they show no indications for the better. Approaching liquidations are much in evidence among some of the smaller dealers, and the credit situation is quite strained. Dealers in the Seattle district report that there is a fair business with gradual improvement.

Electric Signs.—A slight drop in materials involved in electric sign construction and noticeable decreases in costs of installation have been instrumental in causing a movement of this merchandise. It is expected to reach considerable magnitude before the end of the year.

Meters.—An increase in demand is noted with increase in construction. Stocks are in much better condition and deliveries are coming through considerably better.

Rigid Conduit.—New construction, which has shown an appreciable increase since the first of the year, has increased the demand for this merchandise but stocks are more than adequate to care for demand. Prices are fluctuating.

Lamp Cord.—Demand shows slight increase, but stocks are ample and replenishments very easy to obtain. A recent drop in prices is noted.

Ranges.—Deliveries are coming through nicely from Eastern factories for spring and summer business, and from indications this year's sales will measure up favorably with those of 1920. Present sales are light in spite of recent reductions in price.

SALT LAKE CITY—DENVER

An Intermountain newspaper of reputable standing said in its latest weekly financial summary: "Many banks have entirely cleared their indebtedness with the Federal Reserve and are in excellent condition to meet the inevitable demands of the coming spring and summer for money to plant and work crops. The very favorable weather conditions during the present winter have meant very many thousands of dollars to the live-stock and agricultural industries. But the best indication of all is the state of mind in which the farmers and the business men are approaching their 1921 problems. People have recovered their courage and their determination. They have come to realize that because prices dropped was no reason to lose faith or to cease their efforts. On the contrary, they are now working harder, thinking more sanely and practicing a more wholesome economy and thrift than at any time before the high-price balloon began to collapse."

Tape.—The demand for tape in all grades is steady, although it is not moving in big volume. Auto accessory dealers and service stations and garages are big consumers of rubber tape, while the mines and industrial plants use large consignments of friction tape, especially of the better grades. The size of tape almost exclusively in demand is the standard ¾-in. There has been some inquiry for the 1-in. size, but not sufficient to make it worth while for jobbers to stock. Jobbers report ample stocks on hand to meet the present trade demands; the only suggestion of a shortage is in the cheaper grades of friction tapes. One big jobbing house has been under the necessity of picking up odd lots wherever they could be found to fill orders specifying immediate delivery. The price tendency on tape is decidedly downward. A 10 per cent reduction has already been announced to dealers and a new schedule sheet noting further decline is now being prepared by jobbers. The cheaper grade of friction tape is now quoted at 70 cents a pound and the best grade is quoted at $1.15. The price of rubber tape ranges from 75 cents to $1.50 a pound.

Manufacturers' Activities

Devoted to the Business Side of Manufacturing, Distribution and Sales, News from Jobbers and Foreign Fields and a Record of New Devices and Trade Literature

Southern Jobber Holds Optimistic Outlook

According to an announcement of the Piedmont Electric Company, Asheville, N. C., the company, in all its eighteen years of existence, does not recall entering a new year with such ambitious plans for the future and so much enthusiasm for carrying them through as in this new year. The business of the company in the past few months is reported to show a considerable increase over the corresponding period of a year ago. This is taken as a vote of confidence on its policy of sales.

Austin Machinery Company of Louisiana Incorporates

The Austin Machinery Company of Louisiana, Inc., 1020 Maison Blanche Building, New Orleans, has been incorporated under the laws of the State of Louisiana with $100,000 preferred stock and $200,000 common stock as sole distributer for Louisiana, Arkansas, Mississippi and Tennessee of the products of the Austin Machinery Corporation, manufacturer of contractors' equipment. This corporation, it is announced, will carry a full stock of machinery and spare parts for the requirements of municipalities and contractors of excavation, construction, irrigation and drainage projects.

Navy Specifications Issued for Mica and Batteries

The Bureau of Supplies and Accounts, Navy Department, Washington, has issued specifications 17J3, dated Nov. 1, 1920, on hard-rubber jars and hard and soft rubber parts (except separators) used in storage batteries of submarine boats; 17M5b, dated Dec. 1, 1920, superseding 17M5a of July 1, 1915, on mica and pressed-mica plate, and 17S6, dated Jan. 3, 1921, on separators, hard-rubber, for storage batteries for submarine boats.

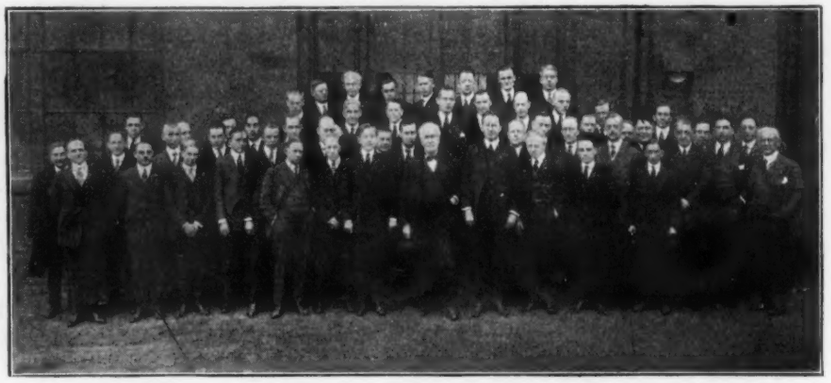
International Clay Products Purchases Properties

Announcement is made that the International Clay Products Company, 31 Union Square, New York City, has recently purchased the entire properties, plant, equipment, coal, clay and shale mines of the Clermont Sewer Pipe Company of Pennsylvania and the Kesco Clay Products Company of New Jersey. The Clermont plant covers 400 acres of land and has an annual capacity of 10,000,000 duct feet of clay conduit. Both plants are reported to be operating at full capacity, and complete stocks are carried for prompt shipment. In addition the company carries cable hangers, conduit coupling rods and pick-up tools.

Edison Storage Battery Takes Optimistic Outlook

F. D. Fagan, recently appointed vice-president and general manager of the Edison Storage Battery Company, Orange, N. J., called in district managers from all over the United States and Canada for a conference with department heads and officials during the week of Jan. 31, at which time general policies for 1921 were outlined.

The tone of the convention was very optimistic concerning the big future awaiting the storage-battery business. One point in support of this view is the confidence exhibited by the New York Edison Company in its electric vehicle show, just completed. Optimism for the future of this business rests on a basis which the company thinks never was more concrete.



EDISON BATTERY DISTRICT MANAGERS GROUPED ABOUT THE "OLD MAN" AT THE FACTORY

Westinghouse Veteran Employees' Banquet Attended by 950 Persons

Nine hundred and fifty members of the Veteran Employees' Association of the Westinghouse Electric & Manufacturing Company attended the eighth annual banquet, held in Pittsburgh on the evening of Jan. 29. The association now includes in its membership more than 1,200 men and women. The speakers at the meeting were Col. H. G. Prout, who was long associated with George Westinghouse and who told of his association, and Dr. W. R. Farmer of the Western Theological Seminary. James McA. Duncan, manager of the Pittsburgh district office, was toastmaster. The new officers elected were: R. W. Patton, president; R. L. Wilson, vice-president, and C. W. Hutchinson, trustee.

Marine Equipment Manufacturers' Association Launched

Among the shipbuilders and manufacturers of marine equipment and supplies who were represented at a meeting in New York City on Jan. 28, at which time what was tentatively called the Marine Equipment Manufacturers' Association was formed, were the American Car & Foundry Company, American Engineering Company, American Steel Foundries, Brunswick Refrigerating Company, Charles Cory & Son, Inc., Crane Company, Cutler-Hammer Manufacturing Company, Electro Dynamic Company, Fairbanks, Morse & Company, Gold Car Heating & Lighting Company, Griscom-Russell Company, International Nickel Company, Locomotive Superheater Company, Niles-Bement-Pond Company, Page Steel & Wire Company, Shepard Electric Crane & Hoist Company, C. H. Wheeler Manufacturing Company and the Westinghouse Electric & Manufacturing Company.

The objects of the association, as given out by its temporary president, Edward A. Simmons, *Marine Engineering*, Woolworth Building, New York City, are: To advance the interests of its members, to promote good will between those who buy and those who sell marine equipment and supplies, to promote and supervise exhibits, and to co-operate with other associations in the marine field to the end that their efforts for the advancement of the designing, building and operation of ships shall be most productive. K. L. Ames, Jr., American Steel Foundries, 332 South Michigan Avenue, Chicago, is acting secretary.

New Equipment Manufacturers' Agency in New England

Arthur H. Abbott, who was formerly connected with the Boston office of the General Electric Company as transformer specialist, has recently gone into business as a manufacturers' agent, with offices at 88 Broad Street, Boston. He is handling Schweitzer &

Conrad outdoor-substation equipment and liquid fuses, "Hi-Voltage" air-break switches, "Ohio" lifting magnets and fractional-horsepower motors, automatic electric control manufactured by the Sundh Electric Company, Karge-Baker flexible couplings, and stokers and steam-jet ash conveyors manufactured by the Frederick Engineering Company.

To Increase Heater Cord Output 50 per Cent

When the new equipment now on hand is installed, the Driver-Harris Company, Harrison, N. J., will be in a position to increase its output of heater cord 50 per cent. The present production is now around 4,000,000 ft. per month, and with this new equipment the capacity will be increased to 6,000,000 ft. The company disposes of its entire heater cord output to appliance manufacturers.

New York Edison's Vehicle Show Brings Results

From first observations, the results of the electric vehicle show staged by the New York Edison Company in its showrooms during the two weeks ended Feb. 12 will fully justify the effort. In speaking with Mr. Skinner, directly in charge of the show, and with various representatives of the companies exhibiting, a representative of the ELECTRICAL WORLD learned that there has been a great deal of serious thought given to the use of the electric vehicle and the industrial truck in solving the problem of transportation.

Representatives of virtually every steamship and railway line in New York City attended, and the volume of inquiries received was very satisfactory.

The important factor observed was the interest in electric vehicles as a whole in working out industrial and transportation problems, rather than interest in the product of any one manufacturer. Of course, there were some orders placed for both kinds of trucks.

Visitors from central stations as far west as Chicago were present and it is highly probable that in the near future similar shows will be instituted in several sections of the country.

Purchasing Agents Discuss Coal Contracts

W. L. Chandler of the Dodge Sales & Engineering Company, Mishawaka, Ind., president of the National Association of Purchasing Agents, has called a meeting of the fuel committee of this organization to be held at the William Penn Hotel at Pittsburgh on Feb. 18 and 19.

The purpose of this meeting is for the fuel committee to meet and discuss a fair, equitable and inviolate form of contract governing the purchase and delivery of coal.

There will be about thirty-seven members of the fuel committee present, each representing a local association, with Ernest H. Hawkins, E. I. du Pont de Nemours Company, Wilmington, Del., as chairman of the committee and of an advisory council of five members of the fuel committee.

It is the purpose of the fuel committee to reach some form of contract which may be standardized, and at a later meeting the advisory council will meet with representative coal operators, distributers and purchasers to secure their advice and co-operation relative to the provisions of the contract as worked out at this meeting.

Long-Bell Lumber Company to Build Mill and Lumber Plant

The Long-Bell Lumber Company, Kansas City, Mo., is planning to erect a large mill and lumber plant on the Cowlitz River at Kelso, Wash. The proposed plant will have a daily capacity of 1,000,000 ft. and will be equipped with electrically driven machinery throughout. The company turns out wood poles of all kinds and other lumber products used in the electrical industry.

Sanborn Electric Enters Appliance Jobbing Field

The Sanborn Electric Company, Indianapolis, contractor, has taken up the jobbing of electrical appliances and will act as distributer for the Bluebird washing machine, Utenco ironer, Blakeslee dishwashing machine, Capitol ironing machine, Rutenber and Simplex heating appliances, etc. A. I. Clifford, who was formerly associated with the Luxam Electrical Supply Company, Fort Wayne, Ind., is in charge of the sales division of the Sanborn company.

Employees' Representatives Co-operate in Wage Reduction

A wage reduction of 13 per cent to piece workers and 8 per cent reduction to hourly and day workers was announced last week by Richard H. Rice, manager Lynn (Mass.) Works, General Electric Company, effective Feb. 14. Salaried employees, whose increases had not been as high as other classes, are not to be reduced at this time. About 11,000 employees will be affected. The reduction was made on the recommendation of the employees themselves through the joint adjustment committee. This committee consists of four members from the employees, chosen through the shop representative system, and four representatives of the company. The recommendation was made unanimously after a series of meetings in which the business situation was thoroughly discussed, and the amount of the reduction was left to Mr. Rice to determine.

No cut will be made at present in the pay of foremen, assistant foremen, leading hands, draftsmen, engineering and co-operative students, apprentices and instructors, because the wages of these groups have increased by a considerably smaller percentage than the wages of others. In announcing the reductions Mr. Rice pointed out that the present business situation demands the most careful handling in order that its effects may be minimized. In addition to lower costs for the future, intense activity along productive lines is essential to preserve the business in hand, he said.

Fort Wayne Works of General Electric to Be Increased

Sixty acres of ground have just been purchased by the General Electric Company in Fort Wayne, Ind., for the expansion of its Fort Wayne works. This property is adjacent to the present property of the company, and it is planned very shortly to begin the erection on this land of buildings which will add about one-tenth to the size of the plant. According to the company officials, the new property is big enough to provide space for the eventual doubling of the size of the Fort Wayne works.

It is the intention of the company to put up two large one-story buildings on a part of this new property, each affording at least 65,000 sq.ft. of floor space. The transformer shop of the Fort Wayne plant, which has been experiencing a splendid boom in business in recent months, will be housed in these buildings.

At the present time the Fort Wayne plant of the General Electric Company occupies a total of 1,300,000 sq.ft. of floor space and under normal conditions employs about 6,000 workers. The erection of the additional buildings will mean that the company will have to employ at least 500 additional workers.

Combustion Official Abroad for Consultation

George E. Learnard, president of the International Combustion Engineering Corporation, 11 Broadway, New York, has just gone abroad to confer with certain officials of the Underfeed Stoker Company, Ltd., of London, England, as well as with some well-known men of France. Through the International company there is close affiliation between the Underfeed Stoker Company, Ltd., London, and the Combustion Engineering Corporation, New York. The Underfeed Stoker Company, Ltd., is planning to build a large new factory near London, and Mr. Learnard is to be present when this work starts. It is also expected that he will be on hand when work is started on a French factory.

Mr. Learnard's belief is that the whole subject of proper combustion engineering is more or less a keystone in any reconstruction and rehabilitation program and that the general moral effect of considering the enormous economies that can be brought about by proper combustion engineering is perhaps more helpful to the general situation than the mere saving of dollars that it represents.

The Thordarson Electric Manufacturing Company, 501 South Jefferson Street, Chicago, announces the appointment of J. L. Finnicum as sales manager. Mr. Finnicum was formerly connected with the Doubleday-Hill Electric Company, Pittsburgh, for more than eight years in the capacity of salesman and in charge of the apparatus department. For the last two years he has been acting as district manager at Chicago for the Electric Products Company, Cleveland.

The Pelton & Crane Company, Detroit, announces the return of the "Pelton" electric furnaces. The company discontinued the manufacture of these furnaces in 1916 when the supply of certain necessary materials was cut off.

The Yale & Towne Manufacturing Company, Stamford, Conn., has filed notice of increase in capital stock from $5,000,000 to $25,000,000.

The Harrisburg Machine & Electric Welding Company, Harrisburg, Pa., recently organized, is planning to establish a machine shop in a building now being erected in the vicinity of Eighteenth and Chestnut Streets, which it is expected will be ready for occupancy about the middle of March. Later the company proposes to erect a new plant at the corner of Eighteenth and Chestnut Streets to provide for increased operations.

The Gwilliam Supply Company, Philadelphia, manufacturer of conduit fittings, has removed its plant from 528 North Hancock Street to 830 North Hancock Street.

The Appleton Electric Company, Chicago, is now established in its new plant at Paulina and Wellington Streets, where it has much larger quarters.

The Crown Chandelier Manufacturing Company, New York City, manufacturer of lighting fixtures, etc., has removed from 103 Mott Street to 610-12 Broadway, where it has considerably more floor space and increased facilities to take care of its rapidly increasing business.

The Mutual Metal Manufacturing Company, 1948 North Kedvale Avenue, Chicago, has been organized to take over the plant of William Christensen, manufacturer of lighting-fixture parts.

The Utility Fittings Company, Philadelphia, manufacturer of electrical conduit fittings, has removed from 812 Walnut Street to 1932 East Westmoreland Street, where its new factory is located. The company, it is said, contemplates taking on several new lines in conjunction with its regular line of products.

The Acme Electric & Manufacturing Company, Cleveland, manufacturer of battery-charging apparatus, dies, tools and gages, has enlarged its factory space and has purchased a new building at 1444 Hamilton Avenue. It has recently developed a motor-generator for motion-picture purposes. The company has established sales agencies as follows: Otto Sarvas, 1966 Broadway, New York City; Elliott Reynolds, Sixty-third and Oxford Streets, Philadelphia; R. H. Barber, 4111 Ravenswood Avenue, Chicago; R. L. Lunt, 716 McKnight Building, Minneapolis; Detach & Company, 555 Turk Street, San Francisco; A. C. Gilchrist, 1444 Hamilton Avenue, Cleveland; L. J. Kaiser, 2476 Park Boulevard, Detroit.

The Crocker-Wheeler Company, Ampere, N. J., announces that it will remove its Philadelphia office from the North American Building to 1209 Arch Street on or about Feb. 15. Samuel Russell, Jr., has been in charge of the Philadelphia office since 1897.

Thebo & Starr, Sharon Building, San Francisco, engineers and constructors, have issued a four-page leaflet showing photographic reproductions of work completed west of the Rocky Mountains since 1905 which was supervised by the members of their firm.

The Delta Electric Company, Marion, Ind., has filed notice of increase in capital stock from $115,000 to $165,000.

J. Livingston & Company, Inc., Grand Central Terminal, New York City, constructing, electrical and mechanical engineers, announces the opening of a branch office at 123 West Madison Street, Chicago, under the supervision of L. F. Brooker, vice-president.

Foreign Trade Notes

GERMANY HAS ELECTRICAL ARTICLES TO EXPORT.—According to a report from the United States Consul at Gothenburg, Sweden, Germany, in its advertising spreads in newspapers of western Sweden, shows that it is now in a position to export many articles of trade, among which are general electrical fixtures, generators, etc.

THE HOOVER SUCTION SWEEPER COMPANY OF CANADA, LTD., will hold its second annual dealer conference at the Royal Connaught Hotel, Hamilton, Ontario, Feb. 9 and 10. Talks on merchandising and selling, business conditions in Canada, etc., are among the subjects to be discussed.

NEW ELECTRIC PLANT IN BLACKBURN, ENGLAND.—The Electricity Committee, according to the London *Times*, has approved revised estimates amounting to £850,000 for the completion of a new electric generating plant. Application will be made to the Electricity Commissioners for permission to borrow £600,000, the difference between the amount already approved and the amount of the revised estimate.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, LTD., London, England, manufacturer of cable, is, according to the London *Electrician*, inviting applications for an issue of 250,000 ordinary shares of £1 at the price of £1 4s. per share, the proceeds to be used to finance expansion in business and to provide for additions to its works to meet future demands.

MARKET FOR ELECTRIC LAMPS IN NETHERLANDS EAST INDIES. — The trade in electric bulbs for the various municipalities in the Netherlands East Indies, according to John A. Fowler, trade commissioner, is controlled by the companies supplying the energy. On the directorate of most of these companies is a firm which before the war was the representative in the Netherlands East Indies for the German General Electric Company. Since the war this firm has been incorporated and has formed a subsidiary company that specializes in electrical supplies. It may be inferred that all supplies for the large municipal plants are routed through this subsidiary company. There are a large number of private installations for estates and some municipal lighting systems outside of the above-mentioned combination.

Foreign Trade Opportunities

Following are listed opportunities to enter foreign markets. Where the item is numbered further information can be obtained from the Bureau of Foreign and Domestic Commerce, Washington, by mentioning the number.

A commercial agent in Spain (No. 34,392) desires to secure the representation of firms for the sale of electric machines for planing and polishing waxed floors, electric stoves, etc.

A commercial agency firm in Ceylon (No. 34,409) desires to secure the representation of manufacturers for the sale of wire, electric lamps and general wiring accessories.

A machinery importing firm in Spain (No. 34,411) desires to secure an agency from manufacturers and exporters for the sale of steam engines, turbines, electrical supplies, etc.

A firm in India (No. 34,412) desires to receive quotations from manufacturers of semi-indirect lighting fixtures, etc.

A commercial agency in Italy (No. 34,413) desires to secure an agency for the sale of electrical fixtures, electrical apparatus, etc.

A firm of engineers in England (No. 34,422) desires to purchase or to secure an agency for articles used in electrical and mechanical engineering, such as glass and metal reflectors or shades and electric motor accessories.

New Apparatus and Publications

MOTORS.—The Allis-Chalmers Manufacturing Company, Milwaukee, has issued bulletin No. 1113, describing its type "Sar" single-phase repulsion motor which it is just placing on the market.

MOTORS.—The Wagner Electric Manufacturing Company, St. Louis, has issued bulletin 125, in which it gives instruction for ordering and adjusting repair parts for the Wagner single-phase motors.

LEATHER BELTING.—The Edward R. Ladew Company, Inc., Glen Cove, N. Y., has recently issued two publications, one entitled "The Proof Book" on leather belting, and the other a catalog describing the manufacture of Hoyt leather belting.

SEPARATORS. — The Griscom-Russell Company, 90 West Street, New York City, is distributing a form sheet describing the new Stratton separator for power plants.

ANGLE FITTINGS, WATER HEATERS AND ROTOMETERS.—The American District Steam Company, North Tonawanda, N. Y., has issued bulletins Nos. 151, 152 and 153, describing its "Adsco Rotometer," "Adsco" water heaters and "Adsco" angle fittings, respectively.

TRANSFORMER AND CHOKE COIL FOR RADIO WORK.—The Clapp-Eastham Company, 139 Main Street, Cambridge, Mass., has issued bulletin ZR3, describing the new Z. R. S. switch modulation transformer and choke coil for radio work which it is about to place on the market.

New Incorporations

THE SEWICKLEY ELECTRIC MANUFACTURING COMPANY has filed articles of incorporation under the laws of the State of Delaware, with a capital stock of $500,000. The incorporators are Arthur J. Kingsbury, L. B. Phillips, A. E. Silver, Dover. The company proposes to manufacture meters.

THE WESTERN ELECTRICAL PORCELAIN COMPANY has filed articles of incorporation under the laws of the State of Delaware, with a capital stock of $550,000. The incorporators are T. L. Croteau, M. A. Bruce, S. E. Dill, Wilmington.

THE PARAGON POWER SPECIALTIES COMPANY, Hartford, Conn., has been incorporated with a capital stock of $5,000 by H. C. Bailey, Louis Z. Richards, Frederick R. Gleason and J. D. Cherry.

THE WESTERN NEW YORK FARM LIGHT & POWER COMPANY, Almond, N. Y., has been incorporated with a capital stock of $6,000 by G. A. and H. A. Guenther and L. B. Stewart.

THE O. K. BATTERY SALES COMPANY, Schenectady, N. Y., has been incorporated with a capital stock of $5,000 by E. J. Sharpley, J. A. Bell and J. A. Franken, Jr.

Record of Electrical Patents

Notes on United States Patents

(Issued Jan. 25, 1921)

1,366,533. BATTERY INDICATING DEVICE; Ralph H. Grant, Dayton, Ohio. App. filed March 31, 1916. For indicating condition.

1,366,534. ANODE; Joseph A. Hall, New Britain, Conn. App. filed June 4, 1919. For electroplating.

1,366,539. TELEPHONE TRUNKING AND SUPERVISORY SYSTEM; Edward A. Mellinger, Chicago, Ill. App. filed June 10, 1909. Automatically trunking.

1,366,544. STARTING AND GENERATING SYSTEM; William A. Turbayne, Niagara Falls, N. Y. App. filed May 20, 1916. Automobile.

1,366,545. DYNAMO-ELECTRIC MACHINE; William A. Turbayne, Niagara Falls, N. Y. App. filed July 20, 1915. Automobile.

1,366,546. DYNAMO-ELECTRIC MACHINE; William A. Turbayne, Niagara Falls, N. Y. App. filed March 27, 1916. For automobile.

1,366,559. PRODUCTION OF ELECTRODES FOR GALVANIC BATTERIES; Harold N. Cox, Glen Ridge, N. J. App. filed April 12, 1919. Caustic alkaline electrolyte.

1,366,562. POLE STRUCTURE; Frank Engel, Niagara Falls, N. Y. App. filed Dec. 13, 1915. For preventing edges on pole pieces from cutting through insulation.

1,366,567. EARPIECE FOR THERMIC TELEPHONES; Pieter de Lange and Robert Aernout, Utrecht, Netherlands. App. filed Nov. 4, 1915. Introduced into the ear.

1,366,580. INDUCTION MOTOR; John Martin, Rugby, England. App. filed Jan. 12, 1920. Large number of possible speeds with two induction motors.

1,366,595. MARINE-ENGINE GOVERNOR OR CONTROLLER; Sydney J. Sanford, Los Angeles, Cal. App. filed Jan. 19, 1918. For preventing the propeller from racing.

1,366,600. RESISTANCE UNIT; William Schwagermann, Yonkers, N. Y. App. filed June 30, 1919. Cylindrical, mounted endwise.

1,366,606. TELEPHONE RECEIVER; Louis Steinberger, Brooklyn, N. Y. App. filed Feb. 27, 1919. Better speech reproducing.

1,366,607. TELEPHONE RECEIVER; Louis Steinberger, Brooklyn, N. Y. App. filed Feb. 28, 1919. Better reproducing.

1,366,617. TELEGRAPHONE; Harry B. Weir, Plainfield, N. J. App. filed Oct. 28, 1916. Speech recording and reproducing.

1,366,627. HIGH-FREQUENCY ALTERNATOR; Ernst F. W. Alexanderson and Samuel P. Nixdorff, Schenectady, N. Y. App. filed Dec. 6, 1918. For radio.

1,366,629. LIGHTING VEHICLES; Morton Arendt, New York, N. Y. App. filed April 25, 1917. Battery-charging system.

1,366,648. LIGHTING FIXTURE; Joseph Goodman, Pittsburgh, Pa. App. filed April 22, 1919. Shade can be vertically adjusted.

1,366,650. SIGNALING SYSTEM; Baxter P. Hamilton, Brooklyn, N. Y. App. filed Feb. 27, 1919. Plurality of signals.

1,366,653. PROCESS OF MODIFYING STARCH; Ellery H. Harvey, Lansdale, Pa. App. filed May 13, 1920. Electrolytic.

1,366,661. INSULATED CLEAT; Bennett G. Jansson, Saugus, Mass. App. field Jan. 23, 1917. Nail for securing telephone wires.

1,366,699. INCANDESCENT ELECTRIC LAMP SOCKET; Norman W. Nutt, Trenton, N. J. App. filed May 3, 1919. Detachable shell.

1,366,700. ELECTRIC SWITCH; Norman W. Nutt, Trenton, N. J. App. filed June 14, 1919. Snap action.

1,366,701. ELECTRIC SWITCH; Norman W. Nutt, Trenton, N. J. App. filed June 14, 1919. Snap action.

1,366,702. INCANDESCENT ELECTRIC LAMP SOCKET; Norman W. Nutt, Trenton, N. J. App. filed Aug. 1, 1919. Keyless.

1,366,720. PROCESS AND PLANT FOR INDUSTRIALLLY CARRYING OUT CHEMICAL REACTIONS IN AN ARTIFICIAL ATMOSPHERE; Marie C. J. E. de Loisy, Paris, France. App. filed June 26, 1919. For chemical processes.

1,366,752. WATER HEATER; Richard M. Stephens, Glen Ellen, Cal. App. filed Dec. 27, 1919. To heat small amounts.

1,366,756. CAUTERY ELECTRODE; Reinhold H. Wappler, Yonkers, N. Y. App. filed Feb. 12, 1919. Surgical.

1,366,794. ELECTRIC WATER HEATER; Frederick Hachmann, St. Louis, Mo. App. filed June 12, 1920. No corrosion.

1,366,799. STORAGE-BATTERY CLIP; Charles F. Hartung, Alhambra, Cal. App. filed Feb. 4, 1919. For charging or testing.

1,366,812. SELECTIVE OR PRINTING TELEGRAPH; Charles L. Krum and Howard L. Krum, Chicago, Ill. App. filed May 17, 1915. Impulses controlled by tape.

1,366,830. FREQUENCY-SELECTING RECEIVING CIRCUIT; Frederick E. Pernot, Berkeley, Cal. App. filed Dec. 19, 1917. Receiving circuit turned.

1,366,838. TRANSMITTER FOR CABLES; Fred L. Rogers, Brooklyn, N. Y. App. filed May 5, 1919. Automatic telegraph.

1,366,840. HEATER; Harry A. Scisinger and Emmett W. Adams, Chicago, Ill. App. filed June 29, 1920. Heat-radiating drum.

1,366,844. VARIABLE-POWER REGULATION; John A. Snee, Jr., West Elizabeth, Pa. App. filed Feb. 16, 1915. To keep wheel under most efficient load.

1,366,851. ELBOW FITTING FOR ELECTRIC INSTALLATION; Wheeler H. Vibber, New London, Conn. App. filed Dec. 2, 1919. Conduit fitting.

(Issued Feb. 1, 1921)

1,366,911. LIGHTING FIXTURE; Harry A. Holloway and Louis E. Trachsel, St. Joseph, Mo. App. filed June 2, 1919. Conveniently attached and detached.

1,366,912. RELAY; William Kaisling, Chicago, Ill. App. filed Oct. 22, 1917. Telephone.

1,366,914. SAFETY CUT-OUT SWITCH; Oliver M. King, St. Joseph, Mo. App. filed July 9, 1919. For series lights.

1,366,916. GASOLINE HEATER; William A. La Belle, St. Louis, Mo. App. filed Sept. 25, 1919. For engines.

1,366,945. RHEOSTAT; Floricel A. Rojas, New York, N. Y. App. filed Feb. 20, 1919. Compression type.

1,366,953. RADIO RECEIVING APPARATUS; Henry K. Sandell, Chicago, Ill. App. filed Oct. 13, 1919. Thermionic or electrionic type.

1,366,960. METER; Rudolph F. Schuchardt, Chicago, Ill. App. filed Nov. 29, 1918. Power factor.

1,366,945. MAGNETIC SEPARATOR; Georg Ullrich, Magdeburg, Germany. App. filed Jan. 21, 1916. Magnetic field in several zones.

1,366,984. WINDING FOR MUTIPLE-SPEED MOTORS; Hans Weichsel, St. Louis, Mo. App. filed July 16, 1919. Single phase.

1,366,996. CONTROLLER-OPERATING MECHANISM; Hubert K. Wood, Bayside, N. Y. App. filed April 19, 1917. Time switch.

1,367,021. ELECTRODE-ADJUSTING MECHANISM; Edwin L. Crosby and Oliver J. Marshick, Detroit, Mich. App. filed Oct. 31, 1919. For rocking furnace.

1,367,089. CONTROL SYSTEM FOR ELECTRIC FURNACES; Raymond T. Pierce, Wilkinsburg, Pa. App. filed Dec. 14, 1918. Constant temperature after initial setting.

1,367,097. ELECTRODE FOR ELECTROLYTIC CELLS AND PROCESS OF MAKING THE SAME; Clarence J. Rottmann, Wilkinsburg, Pa. App. filed April 5, 1917. Condensers, lightning arresters, rectifiers and the like.

1,367,098. APPARATUS FOR PROTECTING METAL-VAPOR RECTIFIERS; Bela B. Schafer, Baden, Switzerland. App. filed Feb. 10, 1920. Aperture of arc-guilding sleeve shut off from cathode by a louver.

1,367,102. CONSTANT-TEMPERATURE DEVICE; Joseph Slepian, Wilkinsburg, Pa. App. filed July 10, 1918. To maintain thermocouple at constant temperature.

1,367,103. SYSTEM OF CONTROL; Gerald F. Smith, Wilkinsburg, Pa. App. filed March 11, 1919. During regenerative period.

1,367,106. CONTROL SYSTEM; Wilfred Sykes, Pittsburgh, Pa. App. filed July 11, 1914. To control voltage of generators.

1,367,118. SYSTEM OF CONTROL; Andrew H. Candee, Pittsburgh, Pa. App. filed June 15, 1917. Electric railway vehicles.

1,367,122. CONSTANT-TEMPERATURE DEVICE; Lewis W. Chubb, Edgewood Park, Pa. App. filed July 10, 1918. For maintaining temperature of a member constant.

1,367,124. ELECTRIC FURNACE; Ora A. Colby, Irwin, Pa. App. filed Jan. 8, 1919. For heaing metal bands.

1,367,125. INDUCTION LIQUID HEATER; Ora A. Colby, Irwin, Pa. App. filed April 7, 1920. Installed in household boiler.

1,367,137. MOTOR-CONTROL SYSTEM; Edward A. Hanff, Wilkinsburg, Pa. App. filed June 11, 1915. Dynamic braking.

1,367,138. MOTOR-CONTROL SYSTEM; Edward A. Hanff, Irwin, Pa. App. filed Nov. 22, 1916. For driving reciprocating mechanisms.

1,367,139. ELECTRICAL SYSTEM; Edward A. Hanff, Irwin, Pa. App. filed Dec. 9, 1916. Control by varying field excitation and polarity of generators.

1,367,140. MEANS FOR CONTROLLING FLASHING IN HIGH-VOLTAGE COMMUTATOR MACHINES; Rudolf E. Hellmund, Swissvale, Pa. Simple and effective.

1,367,155. ELECTRICAL SYSTEM; Walter O. Lum, Pittsburgh, Pa. App. filed May 16, 1916. Operation of reversing rolling mills.

1,367,165. RADIO-TELEGRAPHIC RECEIVING SYSTEM; Haraden Pratt, San Francisco, Cal.

1,367,169. TELEPHONE ATTACHMENT; Harrison D. Sterrick, Pittsburgh, Pa. App. filed July 10, 1919. For supporting receiver.

1,367,212. ROTARY WELDING MACHINE; William S. Southwick, Clinton, Mass. App. filed April 22, 1918. For making fencing.

Construction News

Projects, Plans, Bids and Contracts, Contemplated or Under Way

New England States

AMESBURY, MASS.—The Bryant Body Company is considering operating its plant by electricity and supplying energy to other industrial plants in that section of the city.

BROCKTON, MASS.—The Department of Public Utilities has granted permission to the Edison Electric Illuminating Company to issue $516,600 additional capital stock to pay floating indebtedness and for extensions, etc.

BRIDGEPORT, CONN.—The Tide Water Oil Company, Bostwick Avenue, plans to erect a power house and pumping plant at its local works.

Middle Atlantic States

BROOKLYN, N. Y.—The Brooklyn Edison Company, 13 Willoughby Street, will soon ask for bids for the construction of a power house, 37 ft. x 100 ft., at Livonia and Miller Avenues. G. L. McKnight, engineer, is in charge.

BUFFALO, N. Y.—The City Council is considering plans for the installation of a municipal electrically operated ice-manufacturing plant at the Massachusetts Avenue pumping station. The cost, including equipment, is estimated at about $270,000.

BUFFALO, N. Y.—The Wickwire-Spencer Steel Corporation, River Road, has preliminary plans under way for the installation of considerable electric equipment in the proposed addition to its plant to be constructed at a cost of more than $1,000,000.

DELANCEY, N. Y.—The Delancey Electric Light Company, Inc., has applied to the Public Service Commission for permission to construct and operate an electric power distribution plant.

NEW YORK, N. Y.—Plans have been filed by the New York Edison Company, Irving Place and Fifteenth Street, for the erection of a substation, about 39 x 56 ft., at 159-61 Greene Street, to cost about $160,000.

OLD FORGE, N. Y.—Plans are under way by the Village Council for the construction of a municipal electric power plant to be operated in connection with the water-works system. The cost is estimated at about $50,000. W. D. Morris is clerk.

ATLANTIC CITY, N. J.—The Atlantic City Tire & Rubber Company, 3304 Atlantic Avenue, contemplates the installation of considerable electrical equipment in its proposed automobile tire manufacturing plant, to be built on North Georgia Avenue, at an estimated cost of $70,000.

EDGEWATER, N. J.—Considerable electrical and mechanical equipment, including cranes, hoisting apparatus, conveying equipment, etc., will be installed by the Luckenback Steamship Company, 44 Whitehall Street, New York City, in its proposed new freight terminal in Edgewater.

ELIZABETH, N. J.—The Board of Public Works is considering improvements to the street-lighting system. It is proposed to replace gas lamps with arc lamps.

GLEN MOORE, N. J. — The Delaware River Quarry & Construction Company, 21 Bridge Street, Lambertville, plans to erect a power house in connection with its proposed quarrying and rock crushing plant near here, to cost about $100,000 including equipment. R. A. Montgomery is president.

WOODBRIDGE, N. J.—The lighting commissioners of the seventh district of Woodbridge Township, which comprises, Fords, Hopelawn and Keasbey, contemplates improvements to the lighting system. The cost is estimated at $7,000. W. Lybeck of Fords will be in charge.

ALLENTOWN, PA.—The Pennsylvania Power & Light Company has arranged for an issue of $8,000,000 in bonds, part of the proceeds to be used for extensions and improvements to its plants and system in this section.

CHESTER, PA.—The Delaware County Electric Company contemplates rebuilding its one-story works at Front and Market Streets, recently damaged by fire.

EAST BERLIN, PA.—The East Berlin & Abbottstown Electric Company, recently organized with a capital stock of $15,000, has applied to the borough councils of East Berlin and Abbottstown for franchises to erect poles for an electric distribution system. P. C. Smith is president.

LOCK HAVEN, PA.—The Lock Haven Electric Light & Power Company plans to erect a new electric generating station to cost about $300,000. Work will be started immediately.

PHILADELPHIA, PA.—Bids will be received at the office of the depot quartermaster of the United States Army, Philadelphia, until Feb. 25 for furnishing 14,200 ft. of copper cable.

PHILADELPHIA, PA. — The Federal Trust Company has had plans prepared for the erection of an addition to the power plant on Hicks Street.

BALTIMORE, MD.—Considerable electrical and mechanical equipment will be required in connection with the proposed new municipal hospital to cost about $750,000. Negotiations are under way for an appropriation for the construction of the building.

North Central States

ATWATER, OHIO.—A petition is being circulated for the installation of a lighting system on certain streets in Atwater.

CLEVELAND, OHIO. — The Cleveland Railway Company is considering an issue of $3,000,000 in stock for the construction of a proposed railway power plant. F. Sanders is traction commissioner.

LIMA, OHIO. — The City Council has authorized an expenditure of $180,000 for the installation of an ornamental lighting system on twenty-five blocks in the center of the city and on part of Market and Main Streets.

SOUTH ELGIN, ILL.—A committee, including F. Wills and others, has been appointed to investigate the proposal of erecting an electric transmission line from Elgin to this village. The cost has been estimated at $5,000.

RACINE, WIS.—The Milwaukee Electric Railway & Light Company is considering the extension of its electric distribution lines from Racine to Franksville and Thompsonville and supplying light and power along the proposed route.

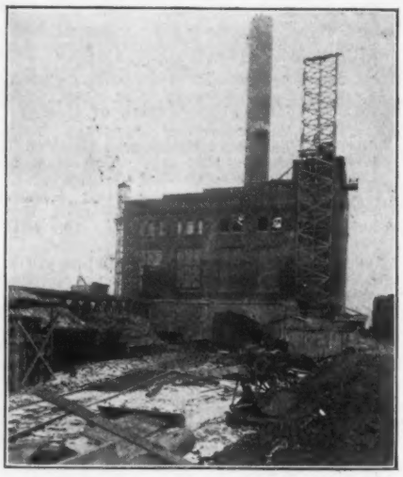
RAMONA, WIS. — A transmission line will be erected from the light and power plant in Madison to supply electricity for the proposed lighting system in Ramona.

NASHWAUK, MINN. — A proposal to issue bonds to the amount of $50,000 for light and water improvements will be submitted to the voters.

SHERBURN, MINN.—The electric light commission of Sherburn is negotiating with the Commonwealth Power Company, Mankato, for the extension of a transmission line from either Truman or St. James to Sherburn.

GRISWOLD, IOWA. — The construction of an electric light and power plant to cost about $50,000 is under consideration by business men here. Tentative plans include the installation of oil engines and three generators, of 200 and 100 direct-connected units, respectively.

KANSAS CITY, MO.—A uniform system of street lighting by electricity to replace the present gas and electric lamps has been recommended by a "get it done" committee. The committee recommends that all multiple lamps be replaced with one-lamp standards. The cost is estimated at about $500,000. The present system consists of 5,621 gas lamps, 153 electric lamps of 600 cp. and 33,856 electric lamps of 250 cp.



A $2,000,000 STATION IS BEING RAPIDLY CONSTRUCTED AT MARION, OHIO, BY SANDERSON & PORTER OF NEW YORK FOR THE COLUMBUS, DELAWARE & MARION ELECTRIC COMPANY

HILLSBORO, KAN. — Bonds to the amount of $60,000 have been voted for improvements to the municipal light plant.

Southern States

JACKSONVILLE, FLA. — Bonds to the amount of $190,000 have been voted for extensions to the street-lighting system and other municipal improvements in South Jacksonville.

OCALA, FLA.—The Cove Company contemplates the development of power on the Wichlacooche River.

GADSDEN, ALA.—The Southern Manufacturing Company contemplates the installation of electric power at its door-manufacturing plant.

NEWTON, ALA. — The Houston Power Company plans to erect a dam and power house on the Choctawhatchee River to develop 2,000 hp.

HARDY, ARK. — The Mammoth Spring Light & Power Company, Mammoth Spring, plans to supply electric energy in Hardy.

PINE BLUFF, ARK. — The Arkansas Light & Power Company has applied to the Arkansas Corporation Commission for a certificate of convenience and necessity to erect 43 miles of high-tension transmission lines between the Picron power plant and Malvern. A similar petition was filed for a line from North Little Rock to Dardanelle for service to a number of adjoining towns. The company also contemplates extending its lines from El Dorado to the oil fields, 6 miles distance. H. C. Couch, Pine Bluff, is president.

OKLAHOMA CITY, OKLA. — Arrangements have been made by the Oklahoma Gas & Electric Company for an issue of $6,000,000 in bonds. Part of the proceeds will be used for proposed extensions to its plants and system. J. J. O'Brien is vice-president.

DALLAS, TEX.—C. A. Mangold, vice-president of the Jefferson Hotel Company, contemplates the organization of a company for the construction of an electric light and power plant.

MISSION, TEX.—Bonds to the amount of $100,000 have been voted for improvements and extensions to the street-lighting, water and sewer systems, etc.

PLAINVIEW, TEX.—The Texas Utilities Company contemplates extending its electric power transmission system to Tulia and Kress. J. B. Scott is manager.

SIPE SPRINGS, TEX.—The Winchester Texas Oil & Refining Company, Fort Worth, contemplates the installation of an electric generating plant for pumping and other purposes in connection with oil development in Sipe Springs field. E. Kimble will supervise the installation of the equipment.

SPUR, TEX.—Grogan & Stovall, Vernon, have purchased the property of the Spur Light & Power Company and contemplate the erection of a power house and other buildings.

Pacific and Mountain States

ELLENSBURG, WASH. — The Kittitas Light & Power Company, recently incorporated with a capital stock of $36,000, contemplates the construction of electric plants. E. E. Wager, J. O. Sorenson and others are incorporators.

SPOKANE, WASH. — The Spokane & Eastern Railway & Power Company contemplates an expenditure of $151,000 for improvements, etc., this year. F. E. Connors is general manager.

WALLA WALLA, WASH. — The City Commissioners contemplate improvements to the street-lighting system.

OAKLAND, CAL.—The Council is considering improvements to the street-lighting system in the downtown section of the city of Oakland.

RIVERSIDE, CAL.—The Southern Sierras Power Company has been authorized by the Railroad Commission to issue $444,260 in bonds for the construction of hydro-electric plants on property formerly owned by the Mono Power Company. A main plant and the Adams auxiliary plant are now under construction.

SAN FERNANDO, CAL. — An electric lighting system will be installed on Mission Boulevard and Kalisher Street.

SANTA PAULA, CAL.—The purchase of an electric fire-alarm system is under consideration by the board of trustees.

CASA GRANDE, ARIZ.—Plans have been prepared by Long & Wichell, Dallas, for the construction of a sanitarium near Casa Grande, including twenty-five main buildings, to cost about $2,000,000. Plans provide for the installation of a lighting system.

PUEBLO, COL.—The Arkansas Valley Railway, Light & Power Company will start work April 1 on the reconstruction of its electric power transmission lines to Rocky Ford. The company plans to change the voltage from 33,000 to 66,000, which will necessitate the replacement of about 5,500 pole insulators. Alterations will be made to the distribution system, including changes in wiring and transformers.

Canada

HAMILTON, ONT.—The Hydro-Electric Power Commisssion of Ontario proposes to erect an 110,000-volt station near here for supplying energy to the easterly limits of the city. Upon completion of this work a new distribution station will be constructed in place of the one now at Gage and Burlington Streets. W. Ellis is chairman of the commission.

LONDON, ONT.—According to a report prepared by Alderman F. E. Harley, which he will submit to the municipalities at a convention to be held in London on Feb. 23 the cost of the electrification of the London, Huron & Bruce Railway is estimated at $1,612,500.

HULL, QUE.—The Ottawa & Hull Power Company will soon ask for bids for an auxiliary steam plant to cost about $300,000. R. Blackburn, Wellington Street, Ottawa, Ont., is superintendent.

Miscellaneous

LEON, GUANAJUATO, MEXICO.—The construction of an electric street-railway system is under consideration by the City Council.

SAN ANDRES TUXTLA, VERA CRUZ, MEXICO.—The municipal authorities are endeavoring to secure American interest and capital toward the construction of a large hydro-electric plant near San Andres Tuxtla, capable of generating 40,000 hp. to be distributed for industrial and domestic purposes. The construction of an electric street railway would also be undertaken in connection with the hydro-electric project.